

## Report from the SMHI monitoring cruise with R/V Aranda



**Survey period:** 2015-06-11 - 2015-06-18  
**Survey area:** Skagerrak, Kattegat, the Sound and the Baltic Proper  
**Principal:** SMHI and the Swedish Agency for Marine and Water Management

### SUMMARY

The expedition was part of the Swedish regular marine monitoring programme and covered Skagerrak, Kattegat, the Sound and the Baltic Proper. Data presented in this report have been subject to preliminary quality control procedures only.

The water temperature in the surface layer was essentially normal for the season. Spring bloom was now over in the Skagerrak and Kattegat areas and nutrients showed low concentrations. Inorganic nitrogen was below the detection limit, while there were small amounts of phosphate left. In the Baltic Sea there was moderate plankton activity. Inorganic nitrogen was below detection limit while phosphate and silicate were higher than normal.

The effect of the inflow during December 2014 had now propagated to the northeast of the eastern Gotland Basin. The bottom water in the Bornholm Basin and Hanö Bight were still oxygenated but the concentration of oxygen was lower than at the previous measurement. In the western Gotland Basin the oxygen situation was still severe as acute hypoxia occurred from depths exceeding 60-70 meters and hydrogen sulphide from about 90 meters deep.

The next cruise is planned to start July 20, 2015.

## **PRELIMINARY RESULTS**

The cruise, performed on board the Finnish research vessel Aranda, began in Helsinki on June 11 and ended in the same port on the 18<sup>th</sup>. The winds during the expedition were mainly mild to moderate. In parts of Kattegat and Skagerrak, however, the wind increased and on a few occasions there were at gale force. Air temperatures ranged from 10.1 – 16.2° C.

### **The Skagerrak**

The salinity of the surface layer showed small variations around 30 psu. Surface water temperature was normal for the season and varied between 12.4 and 13.2 ° C. The halocline and thermocline were found at around 10-20 meters depth.

The nutrients in the off shore surface water was now almost exhausted while they were slightly higher at the coast. Phosphate concentrations in the off shore surface water ranged between 0.02 and 0.04 µmol/l, nitrite + nitrate was around 0.1 µmol/l, while the concentrations of silicate varied between 0.3 and 1.8 µmol/l. Close to the coast, the corresponding levels were 0.07 for phosphate, 1.05 for nitrite + nitrate and 4.9 µmol/l for silicate.

Fluorescence measurements showed low biological activity except near the halocline where it was slightly higher fluorescence. The bloom of diatoms which was ongoing during last expedition was now over.

### **The Kattegat and the Sound**

The temperature of the surface water was normal for the season and varied between 14.8 °C in the south to 13.2 °C in the north. In the Kattegat, the surface salinity was normal, between 20.4 and 22.1 psu. In the Sound, the salinity was slightly lower than normal, around 9 psu. Halocline and thermocline were found at 15 to 20 meters depth.

The concentrations of nutrients in surface water were normal for the season except for silicate that showed levels higher than normal. The spring bloom in the surface layer was over while higher fluorescence still was measured adjacent to the halocline. Phosphate concentrations were 0.04 µmol/l in the entire Kattegat, silicate ranged from 1.8 in the north to 2.9 µmol/l in the south. In the Sound the corresponding values were 0.24 for phosphate and 6.8 µmol/l of silicate. Inorganic nitrogen was below the detection limit throughout the area down to 15 meters.

The lowest oxygen levels in bottom water were measured at Anholt E in the Kattegat, 5.04 ml/l and at W Landskrona in the Sound, 4.32 ml/l.

### **The Baltic Proper**

The temperature of the surface layer was normal for the season and varied from 11.1°C to 14.5°C. Sea surface salinity was slightly above normal in southwestern Baltic and slightly below normal in north-eastern parts, varying from 6.5 psu in the northeast to 8.0 psu in southwest. The halocline was found at 60-80 meters depth in the Western and Eastern Gotland Basins, while it was becoming shallower in the south. In the Arkona Basin it was found at 30-40 m depth.

Phosphate and silicate was still above normal and ranged from 0.23 to 0.53 µmol/l and 8.6 - 17 µmol/l, respectively, with the highest concentrations in the southeast and in the southern part of the Western Gotland Basin. Inorganic nitrogen was completely exhausted down to 20 meters throughout the Baltic.

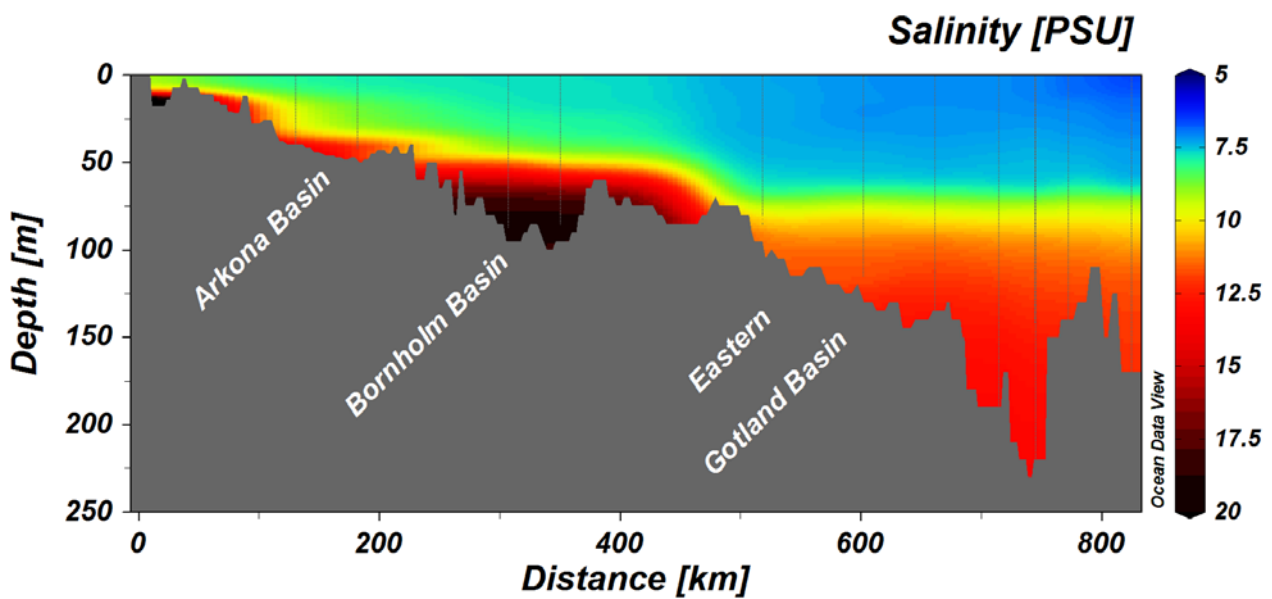
Fluorescence measurements showed moderate plankton activity in the area.

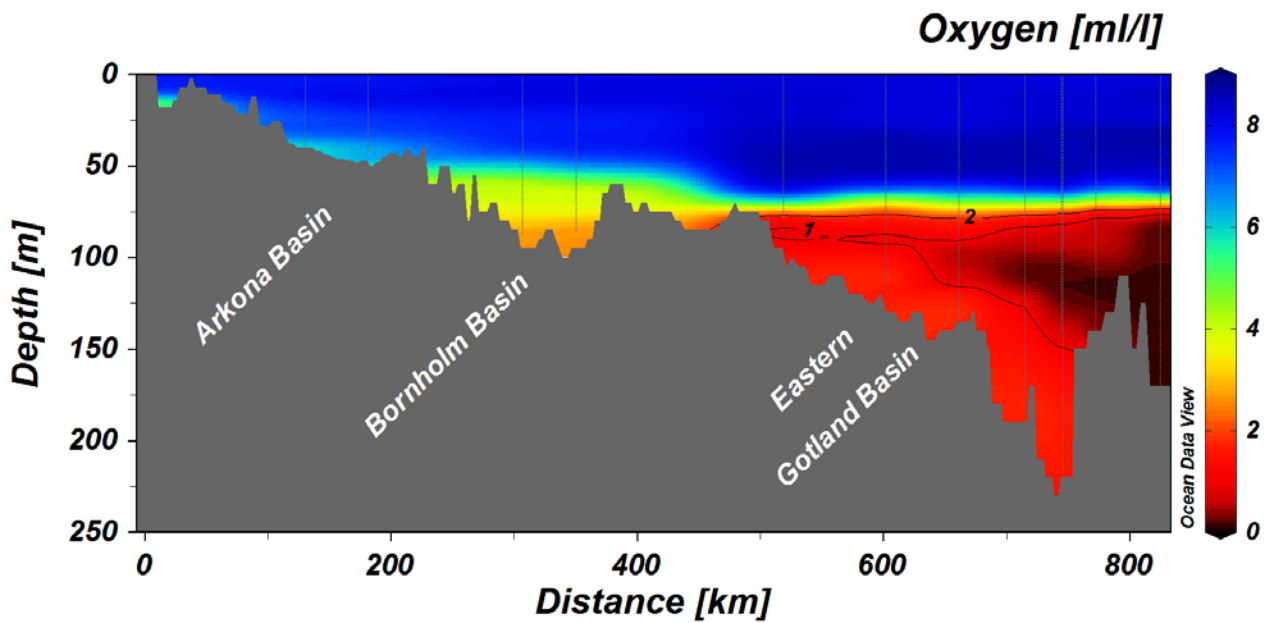
The large inflow to the Baltic Sea, which took place in December 2014 had now propagated further north in the Eastern Gotland Basin and was now visible between Fårö Deep (BY20) and Gotland Deep (BY15) as a thin layer at the bottom.

In the northern part of the Eastern Gotland Basin (BY20) the effects of the inflow was visible, both in the halocline as well as in that the concentrations of hydrogen sulphide at depths exceeding 110 meters had fallen slightly.

In the Gotland Deep acute hypoxia occurred at depths exceeding 70 meters. Hydrogen sulphide was found intermediate but only around 115 meters depth. The bottom water was now fully oxygenated below this layer, but the maximum concentration of oxygen had been reduced by approximately 1 ml/l, from 2.61 ml/l to 1.63 ml/l, since the previous survey in April. The salinity of the bottom water had slightly decreased while it had increased in the intermediate water around 100-150 meters. In the southernmost part of the Eastern Gotland Basin acute hypoxia prevailed from 75 meters depth and the oxygen content in the bottom waters had decreased from 2.2 ml/l in the previous survey to 0.4 ml/l. In the Bornholm Basin and in the Hanö Bight, there was no oxygen deficit in the bottom water but oxygen levels had decreased since the previous measurement, here with about 1.5 ml/l. Oxygen levels had also fallen in Arkona bottom waters, from 5-6 ml/l at the last visit to concentrations around only 2 ml/l.

In the Western Gotland Basin the oxygen situation remains serious. Completely oxygen-free conditions was found from 80-90 meters and acute hypoxia (<2ml/l) from 60-70 meters.





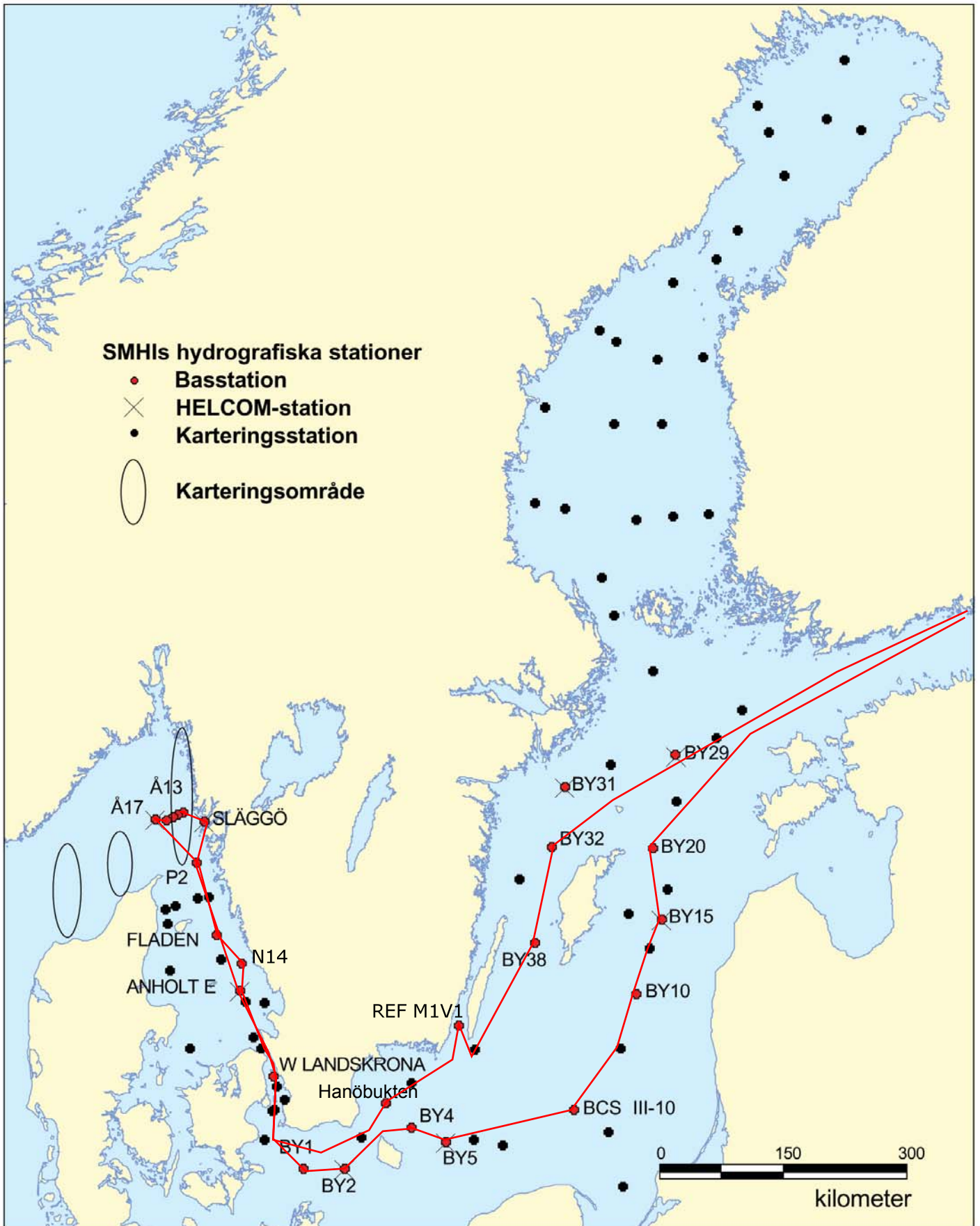
## PARTICIPANTS

Name		Institute
Karin Wesslander	Chief scientist	SMHI
Lars Andersson		SMHI
Johan Håkansson		SMHI
Johan Kronsell	(Helsingfors-Lysekil)	SMHI
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## APPENDICES

- Track chart
- Table over stations, parameters and sampling depths
- Map showing bottom oxygen concentrations
- Monthly average surface water plots for selected stations
- Vertical profiles for selected stations

TRACKCHART  
Country: Sweden  
Ship: R/V ARANDA  
Date: 20150611-20150618  
Series: 0325-0351



SMHI  
Ocean enh

\*\*\*\*  
\*\*\*\* Hydrographic series

Ship: 01-Aranda  
Year: 2015

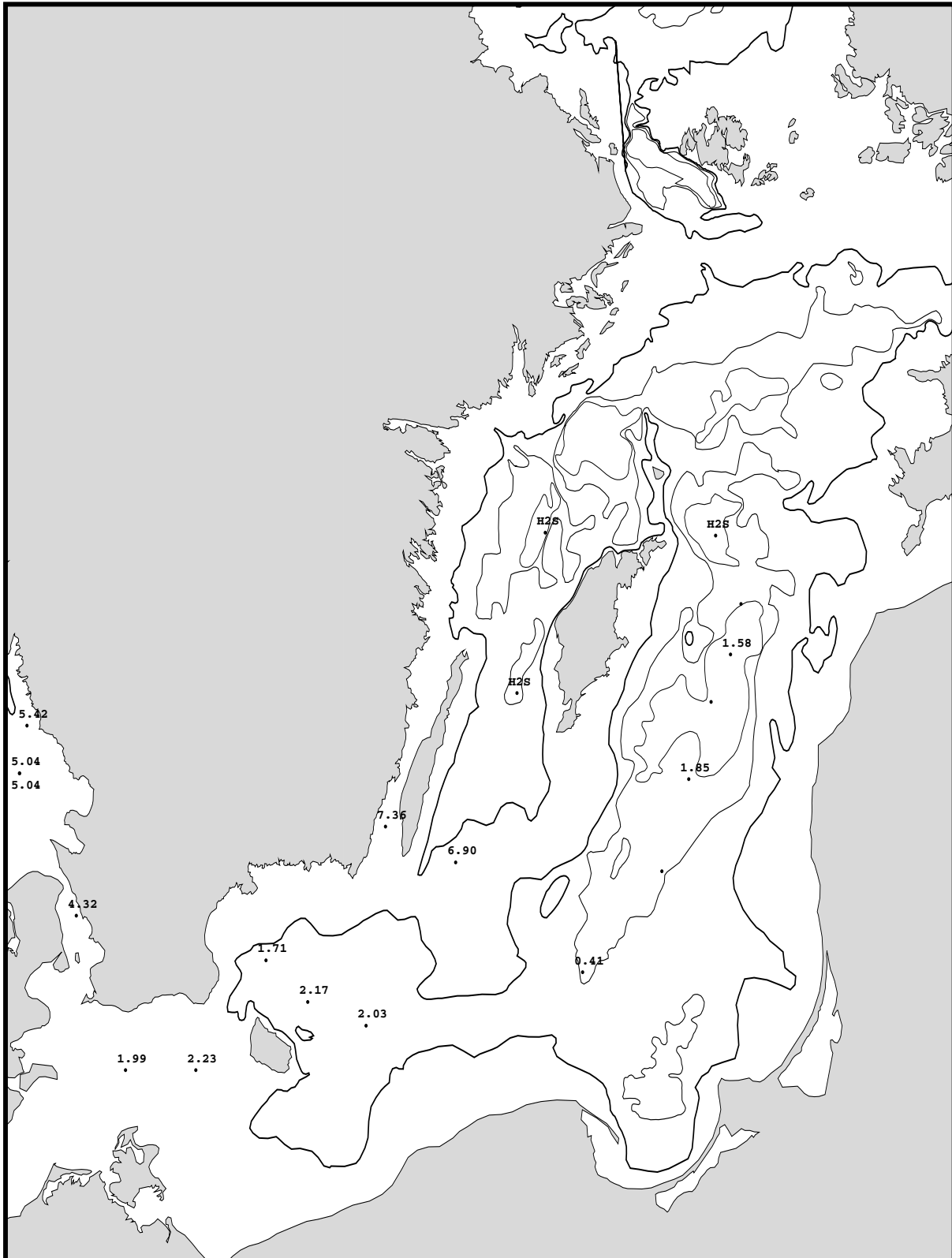
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Date: 2015-06-17  
Time: 16:42

Ser no	Stat code	P r o j	Station-----	Lat-----	Lon-----	Date yyyymmdd	Time hhmm utc	Bottom depth m	Secchi depth m	Wind di ve	Air temp C	Air pres hPa	WCS elec t	C aoae d	PPCPZZT Cilyooa motPBw PrP l	No de e	T e a	S h x	P 2	O S	H 4	P t	T 2	N 3	N 4	N t	A h o l i u i	S t k O m g N C C m	L 3 u n	P P T C				
0325	BPEX26BAS	BY20	FÄRÖDJ	N5800	E1953	20150612	0905	193	6	22 4	12.3	1013	1130	x	--x----	17	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	x	
0326	BPEX25EXT	BY19		N5737	E2010	20150612	1210	158		20 9	12.0	1014	1130	x	-----	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
0327	BPEX21BAS	BY15	GOTLANDSDJ	N5720	E2003	20150612	1410	238	6	20 9	10.7	1014	4930	x	-xxxx--	19	x	x	x	x	x	x	x	x	x	x	x	x	x	-	-	-	-	-
0328	BPEX21EXT	BY15	GOTLANDSDJ	N5720	E2003	20150612	1550	238	6	20 9	10.1	1013	4930	x	-----	5	x	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-	-	
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0330	BPEX13BAS	BY10		N5638	E1935	20150612	2105	145		19 6	13.1	1011	9990	x	-----	15	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-	-	-	
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# Bottom water oxygen concentration (ml/l)

Country: Finland  
Ship : Aranda  
Date : 20150612-20150617  
Series : 0325-0351

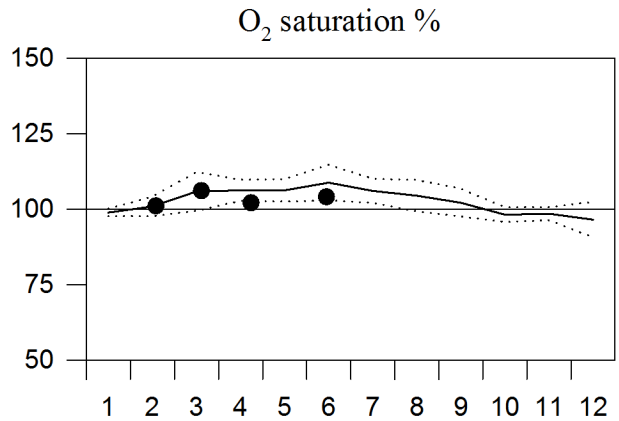
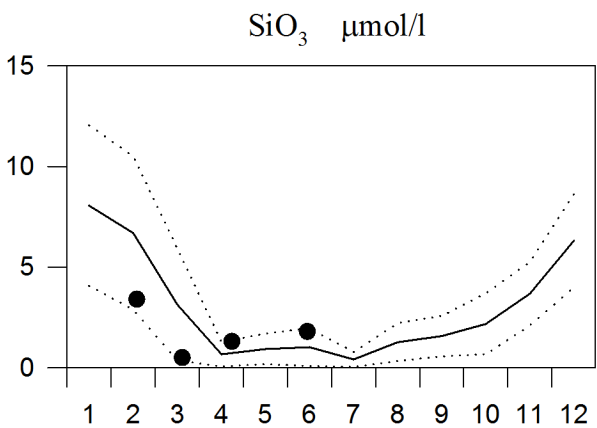
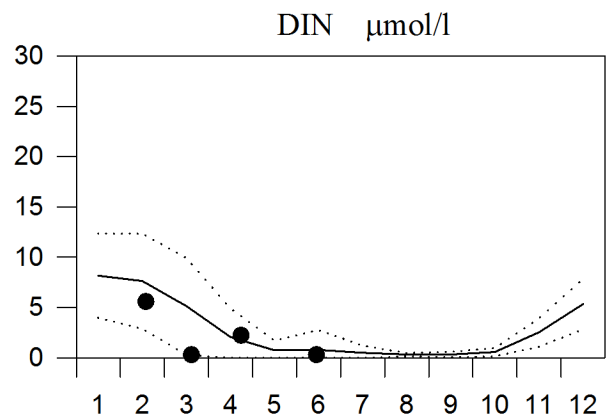
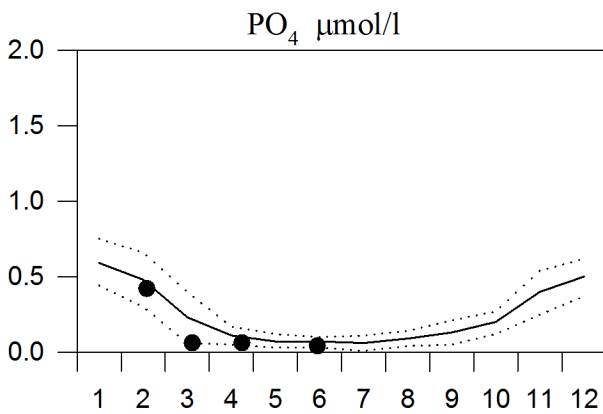
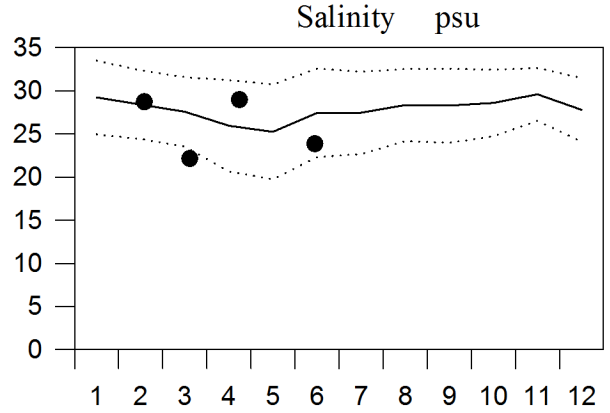
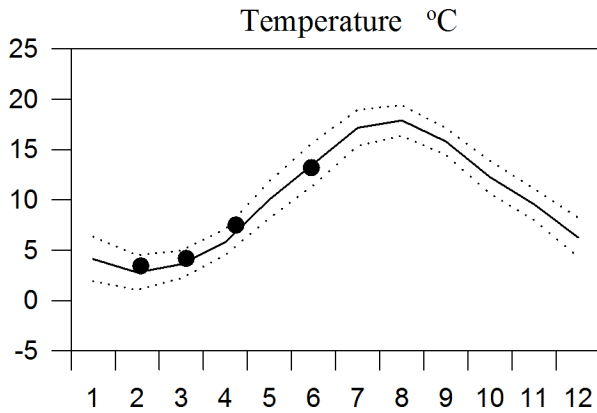




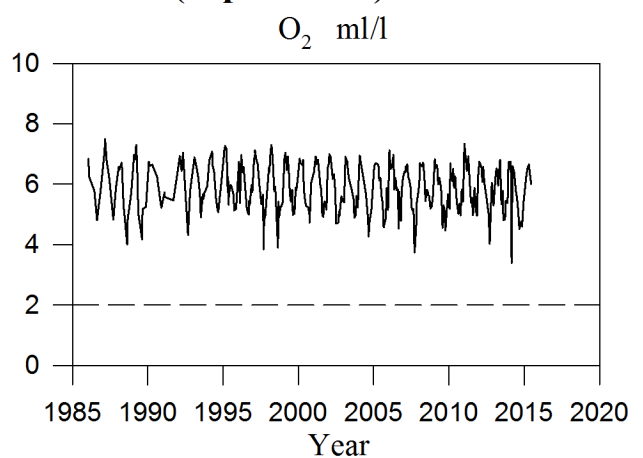
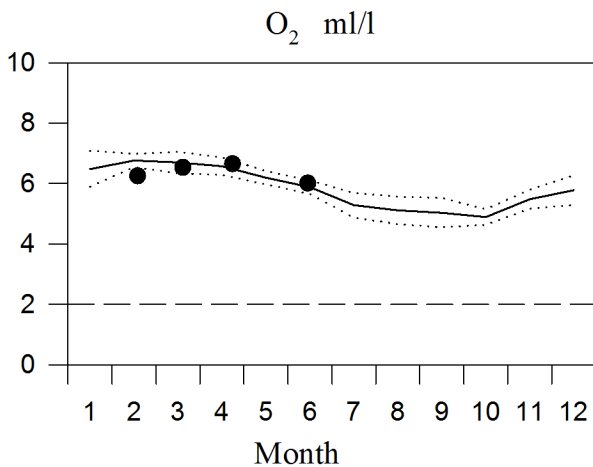
# STATION P2 SURFACE WATER

## Annual Cycles

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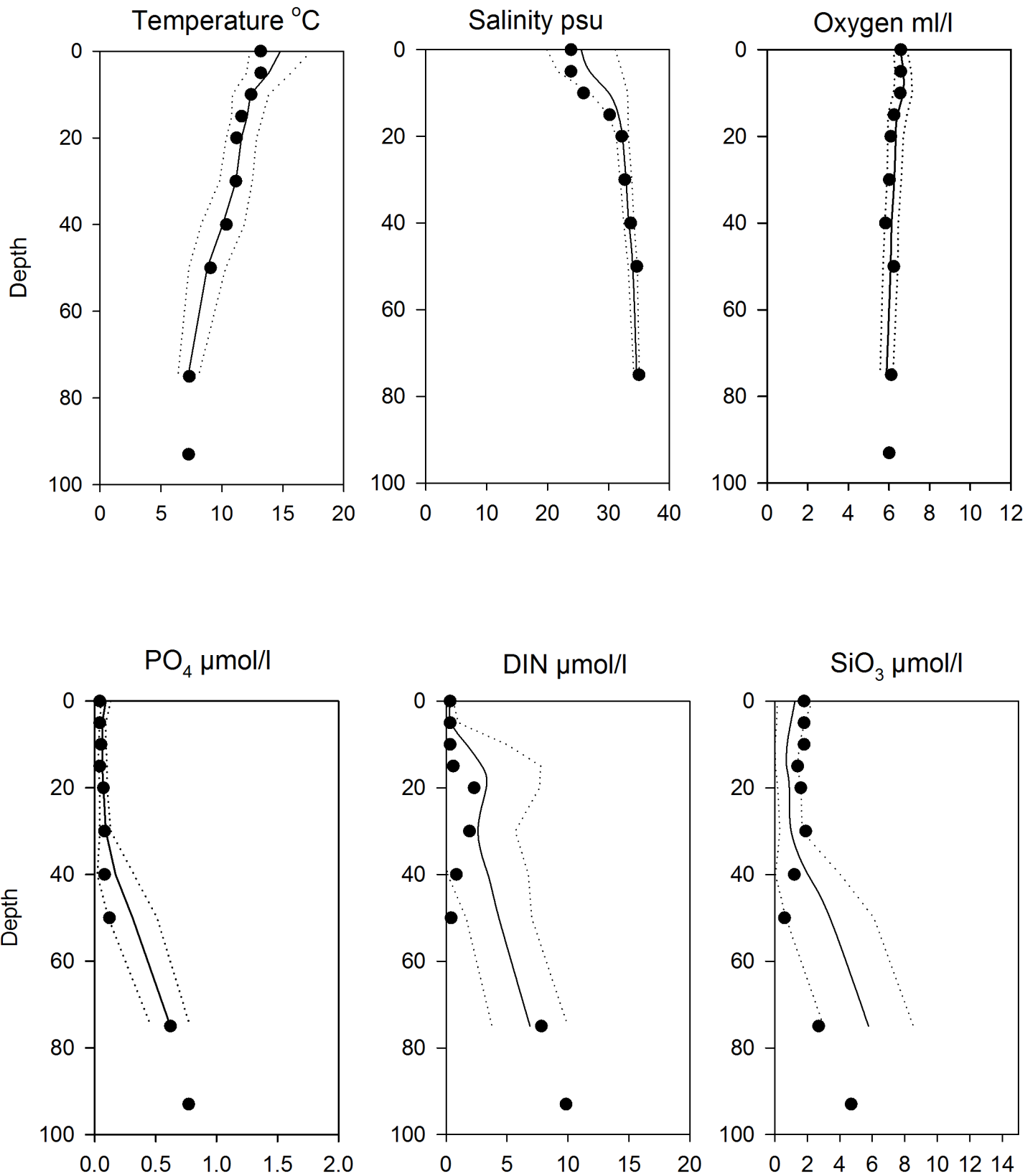
## OXYGEN IN BOTTOM WATER (depth >75m)





# Vertical profiles P2 June

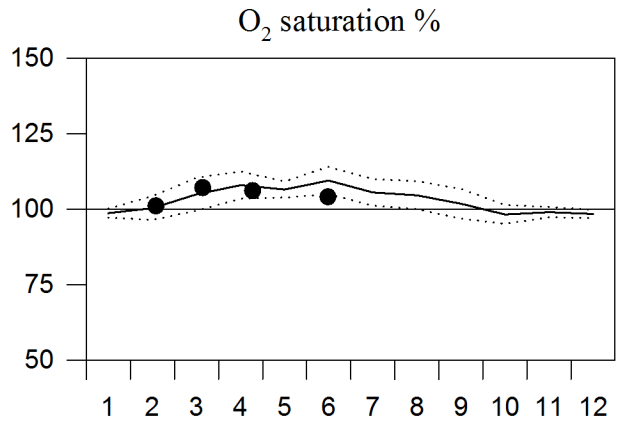
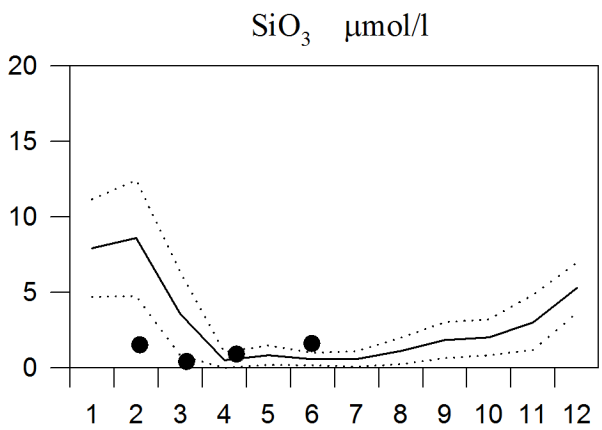
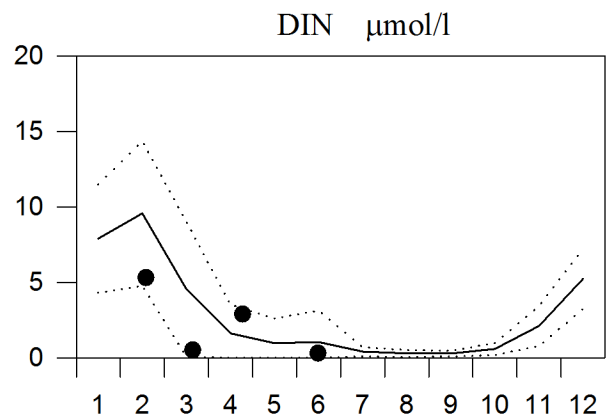
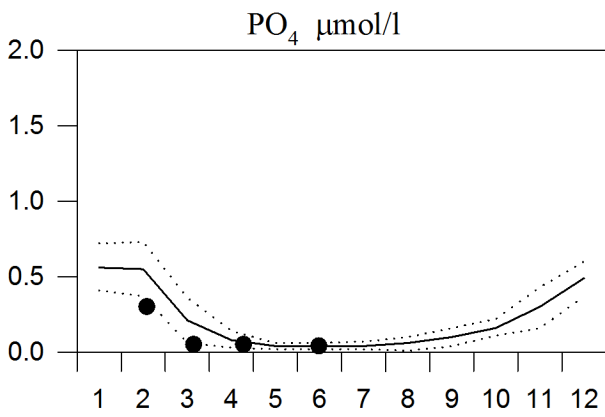
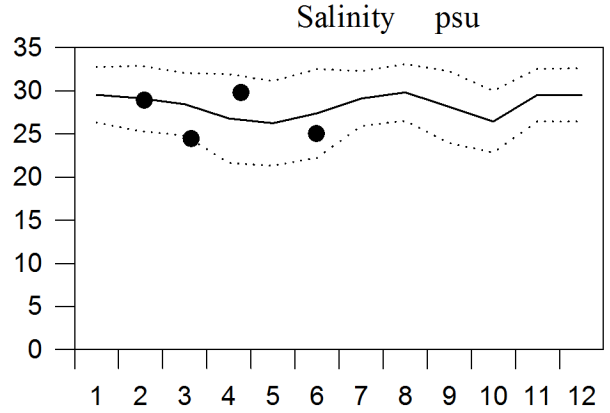
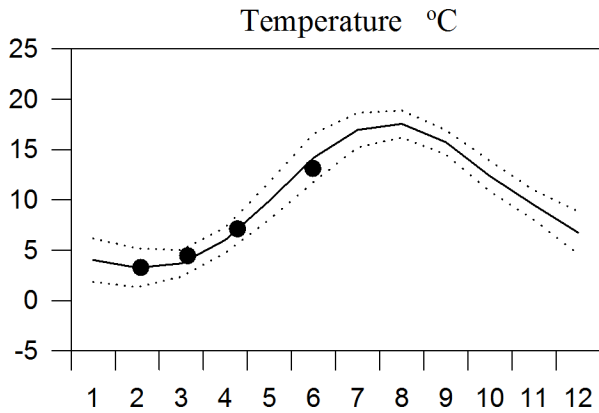
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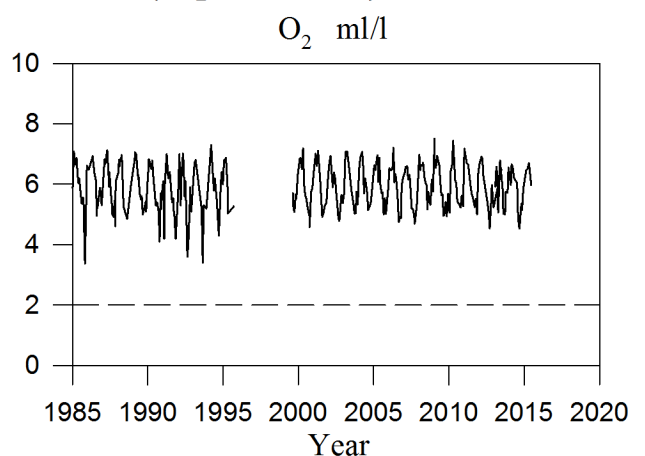
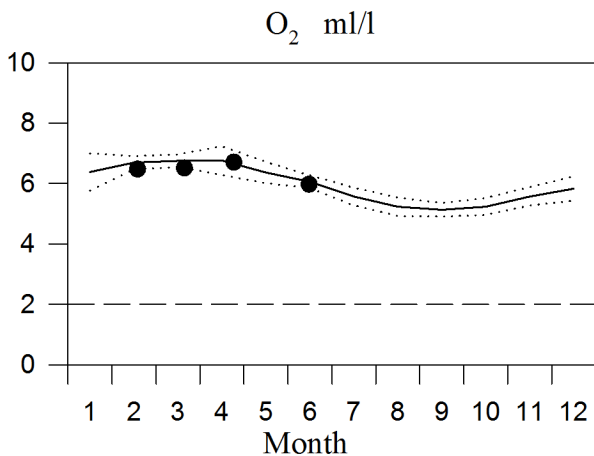
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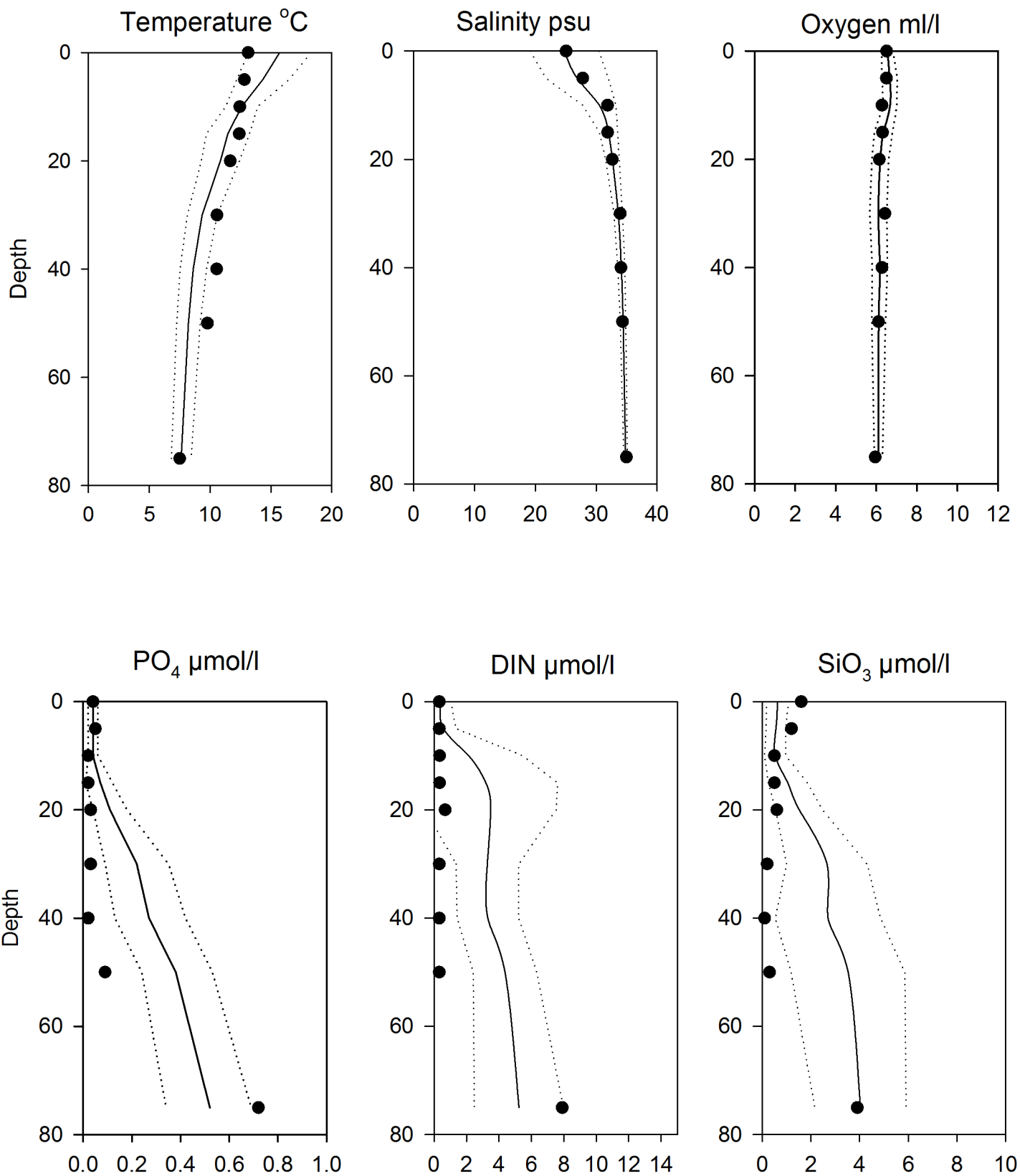


## OXYGEN IN BOTTOM WATER (depth >=75m)



# Vertical profiles Å13 June

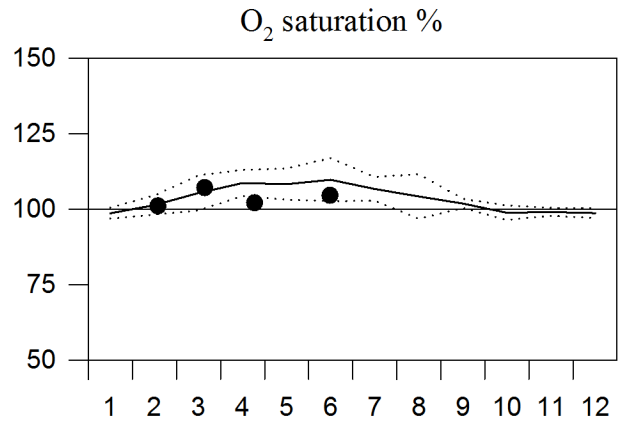
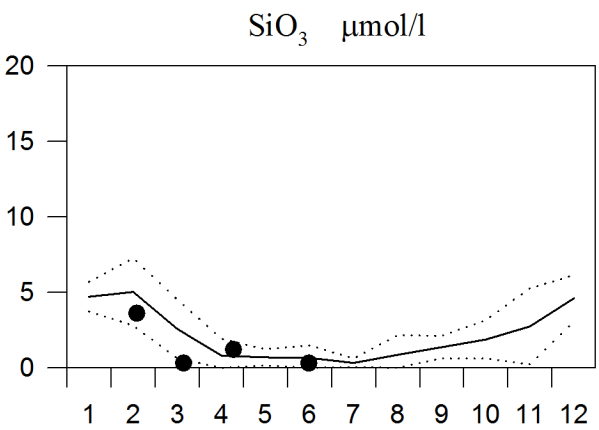
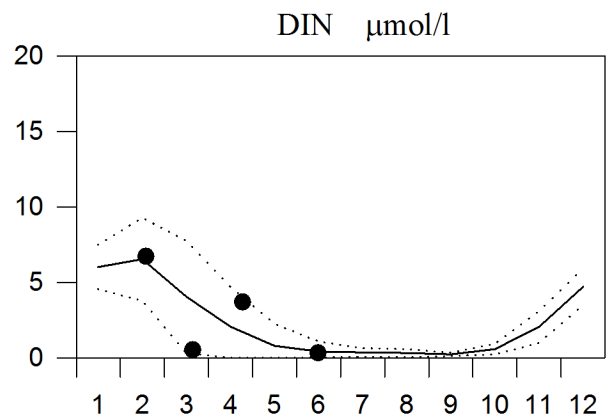
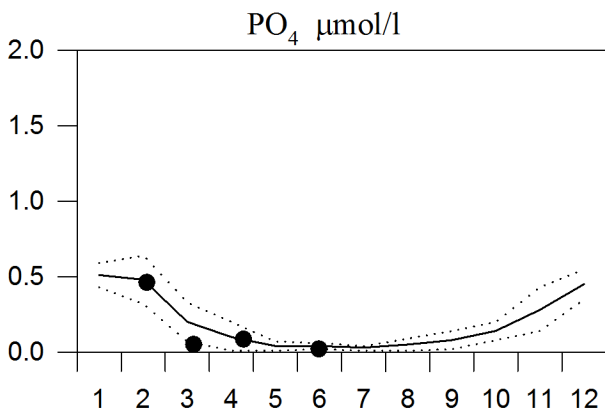
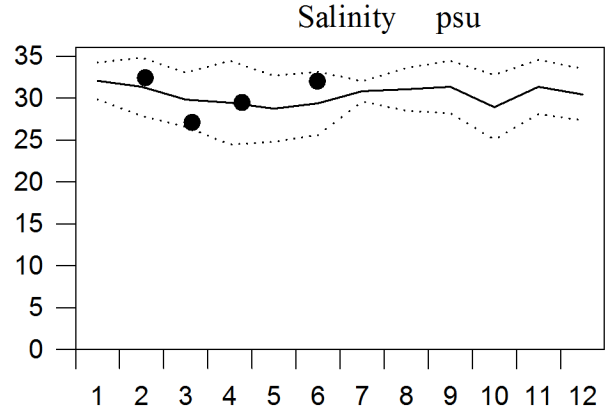
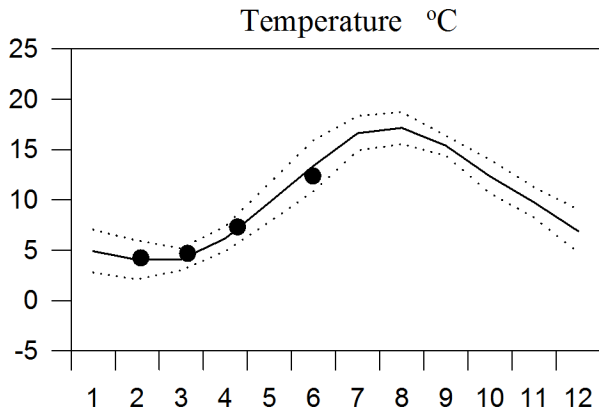
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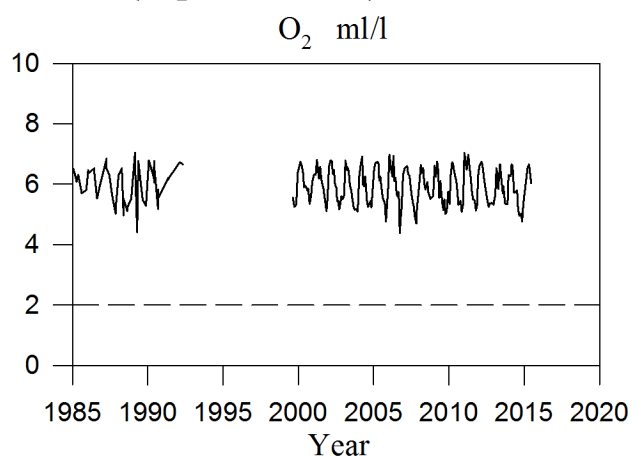
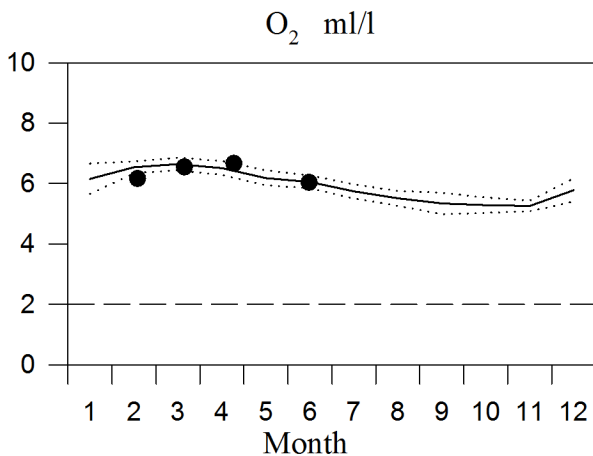
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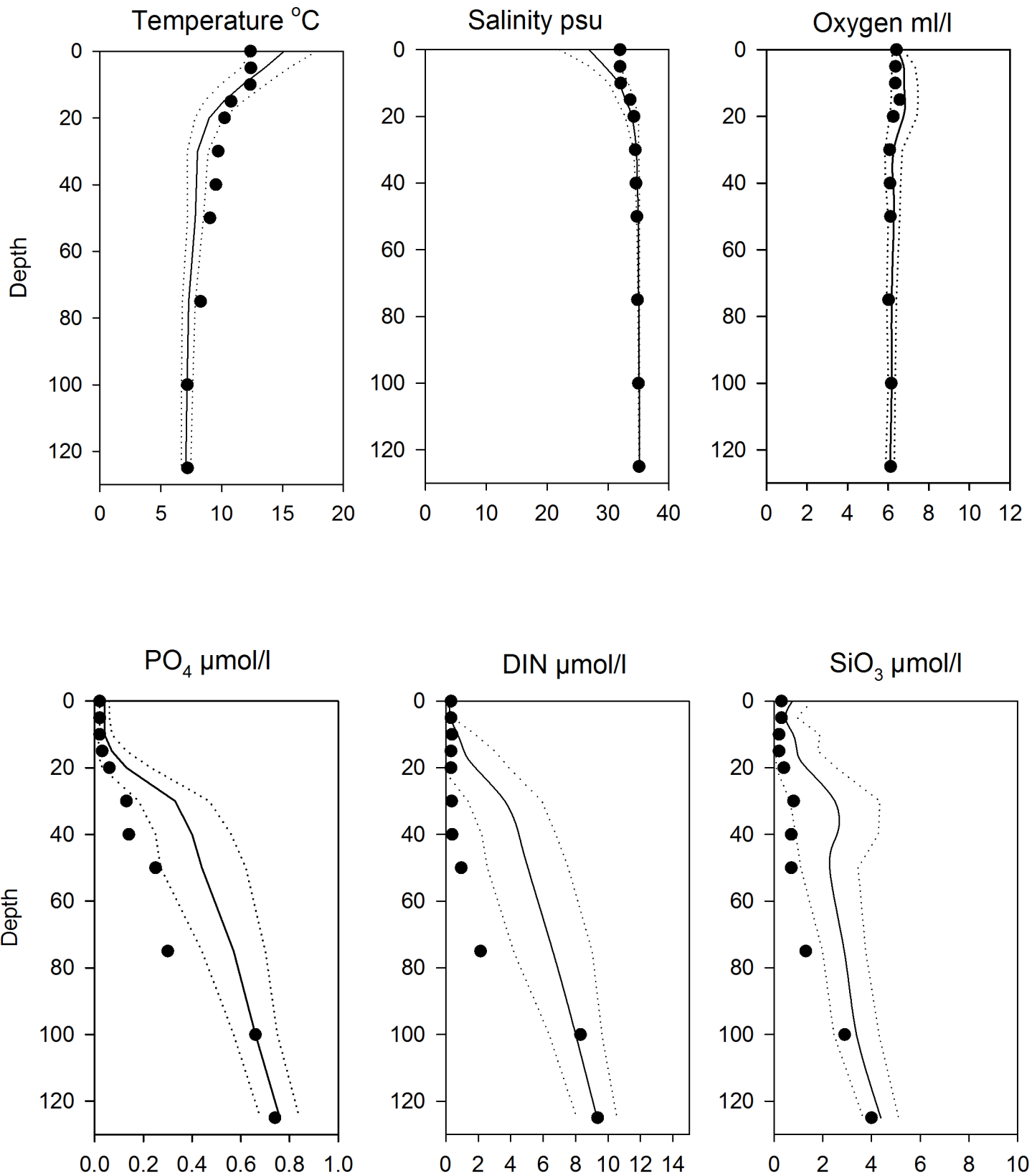


## OXYGEN IN BOTTOM WATER (depth >=125m)



# Vertical profiles Å15 June

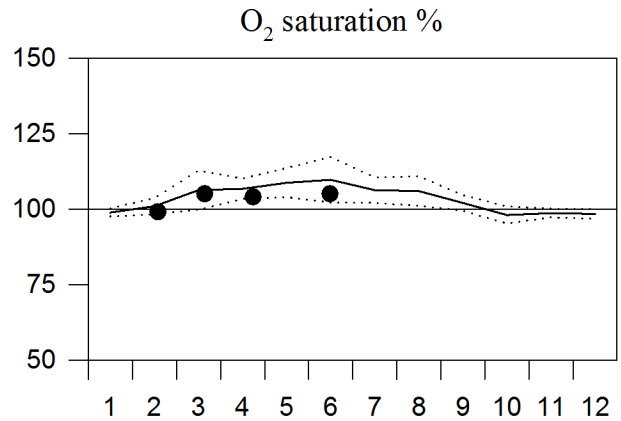
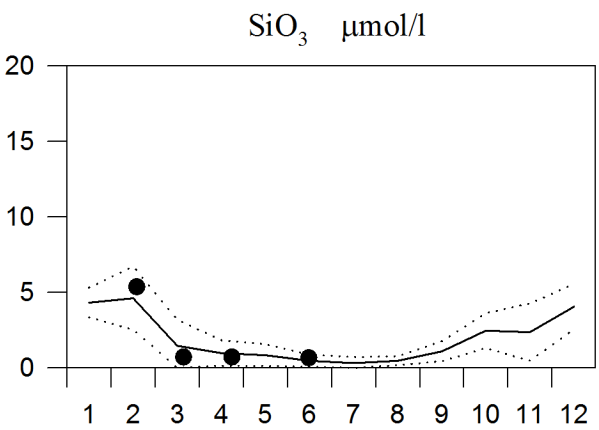
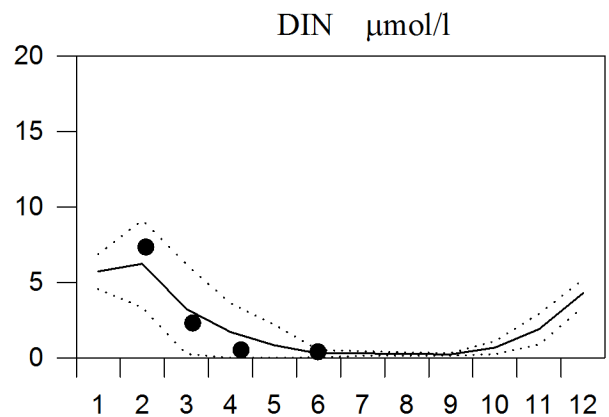
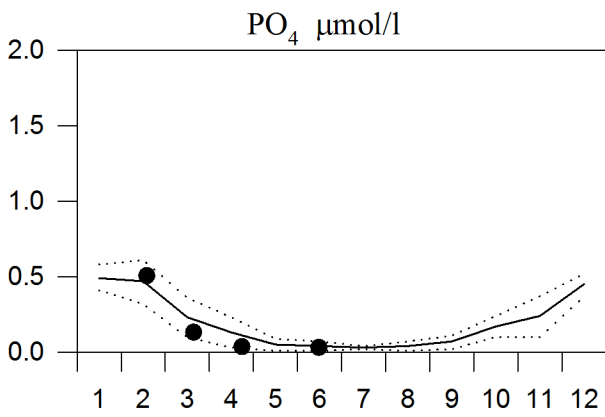
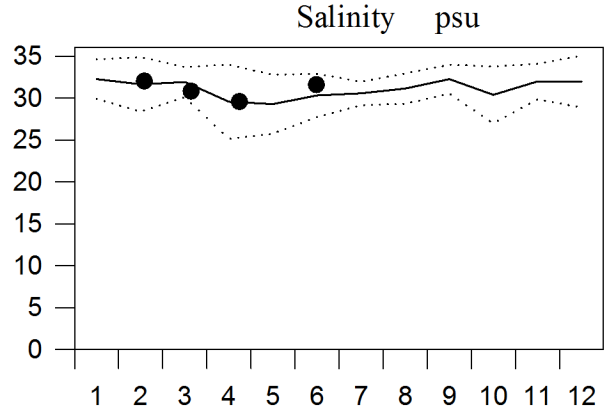
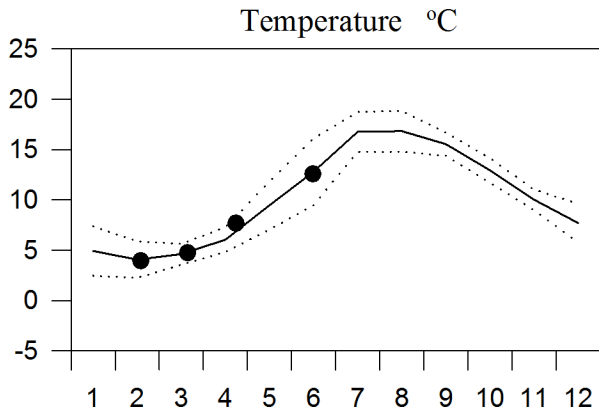
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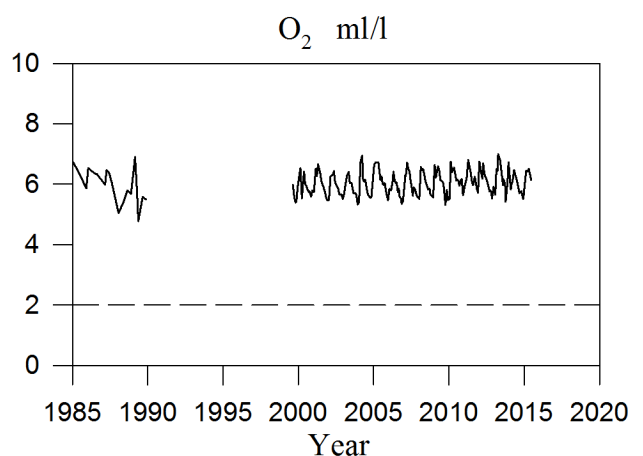
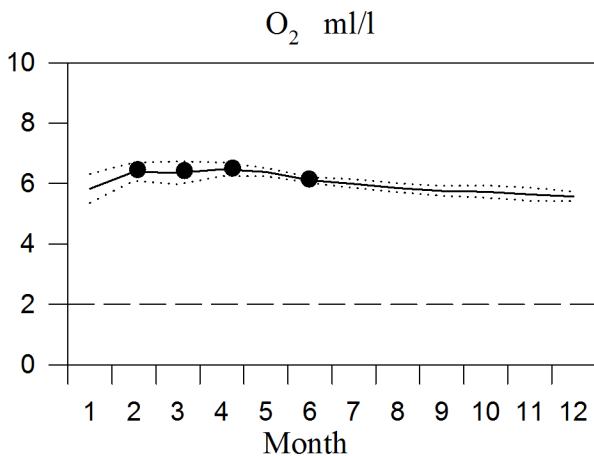
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## Annual Cycles

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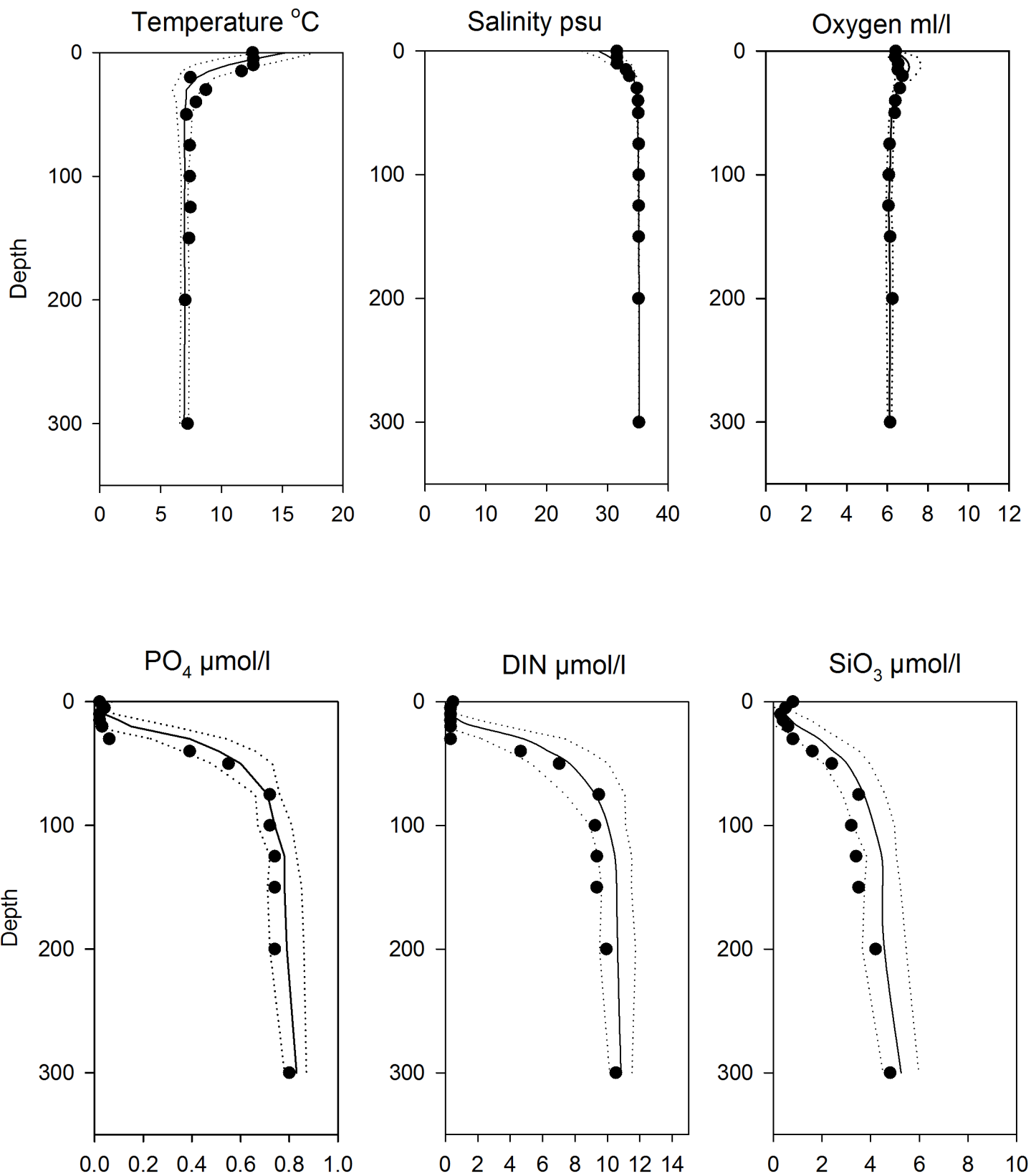


## OXYGEN IN BOTTOM WATER (depth = 300m)



# Vertical profiles Å17 June

— Mean 1996-2010      ..... St.Dev.      ● 2015

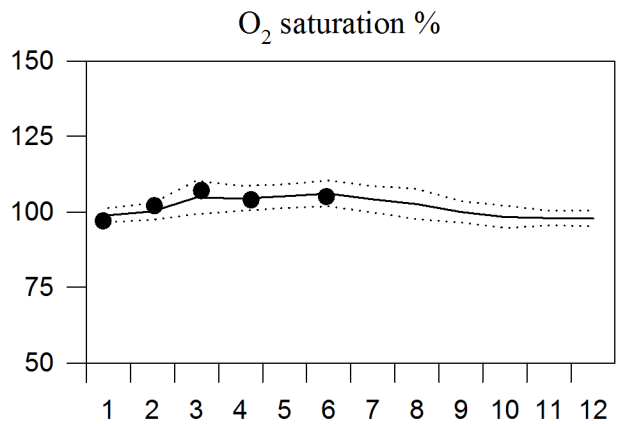
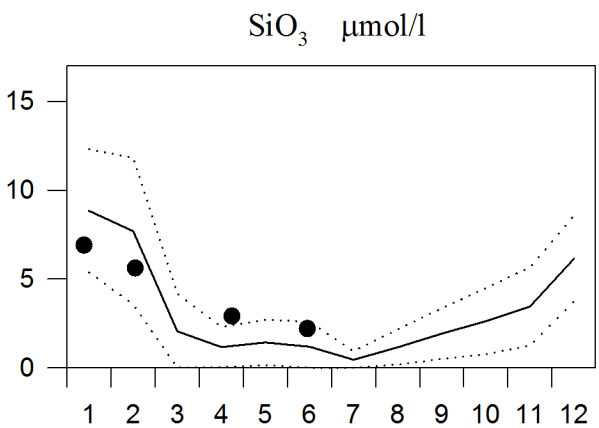
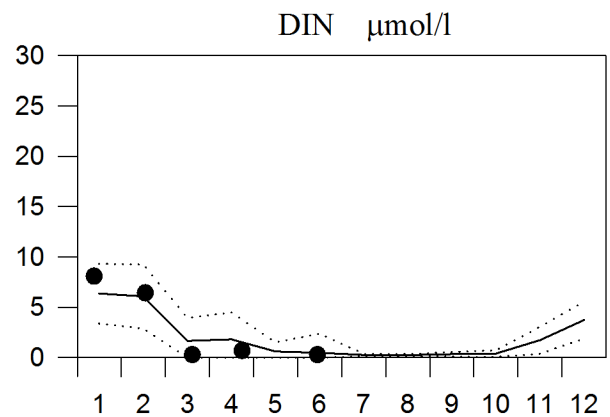
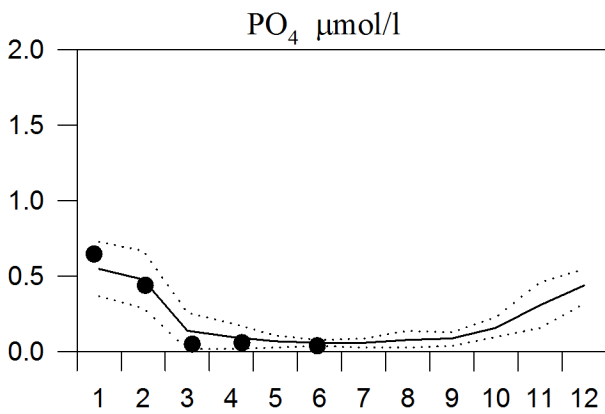
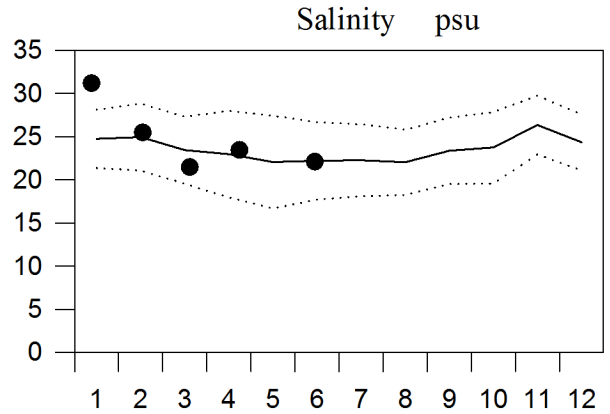
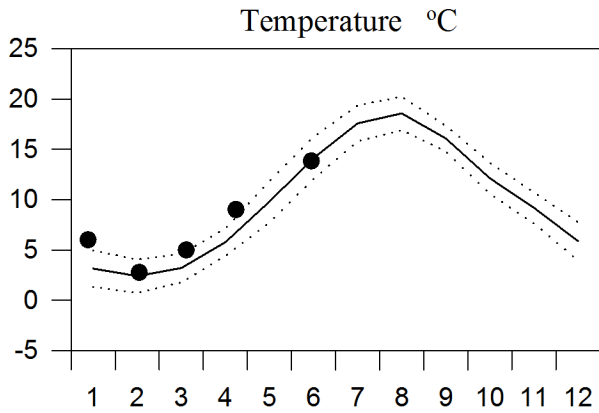




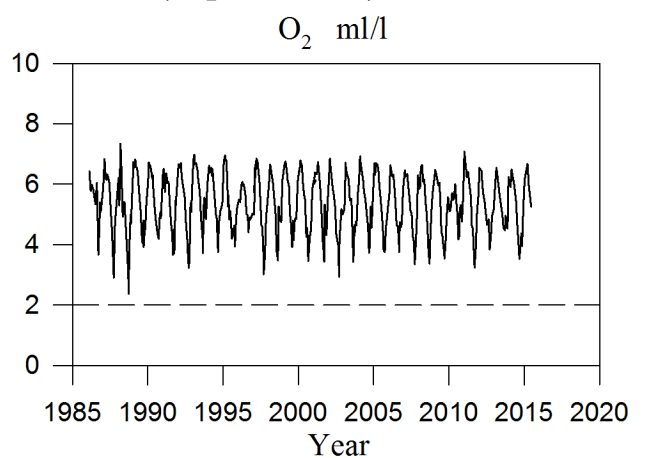
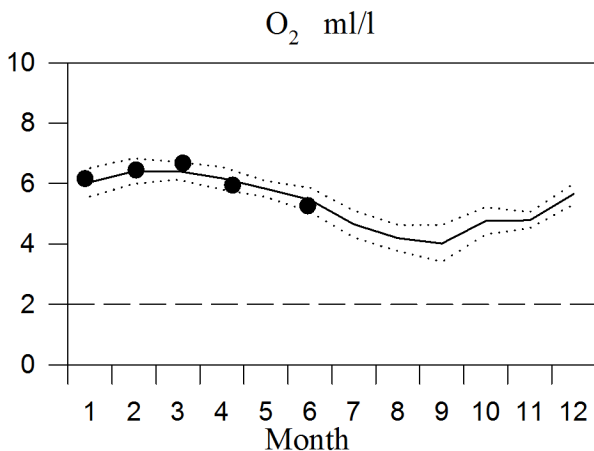
# STATION FLADEN SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

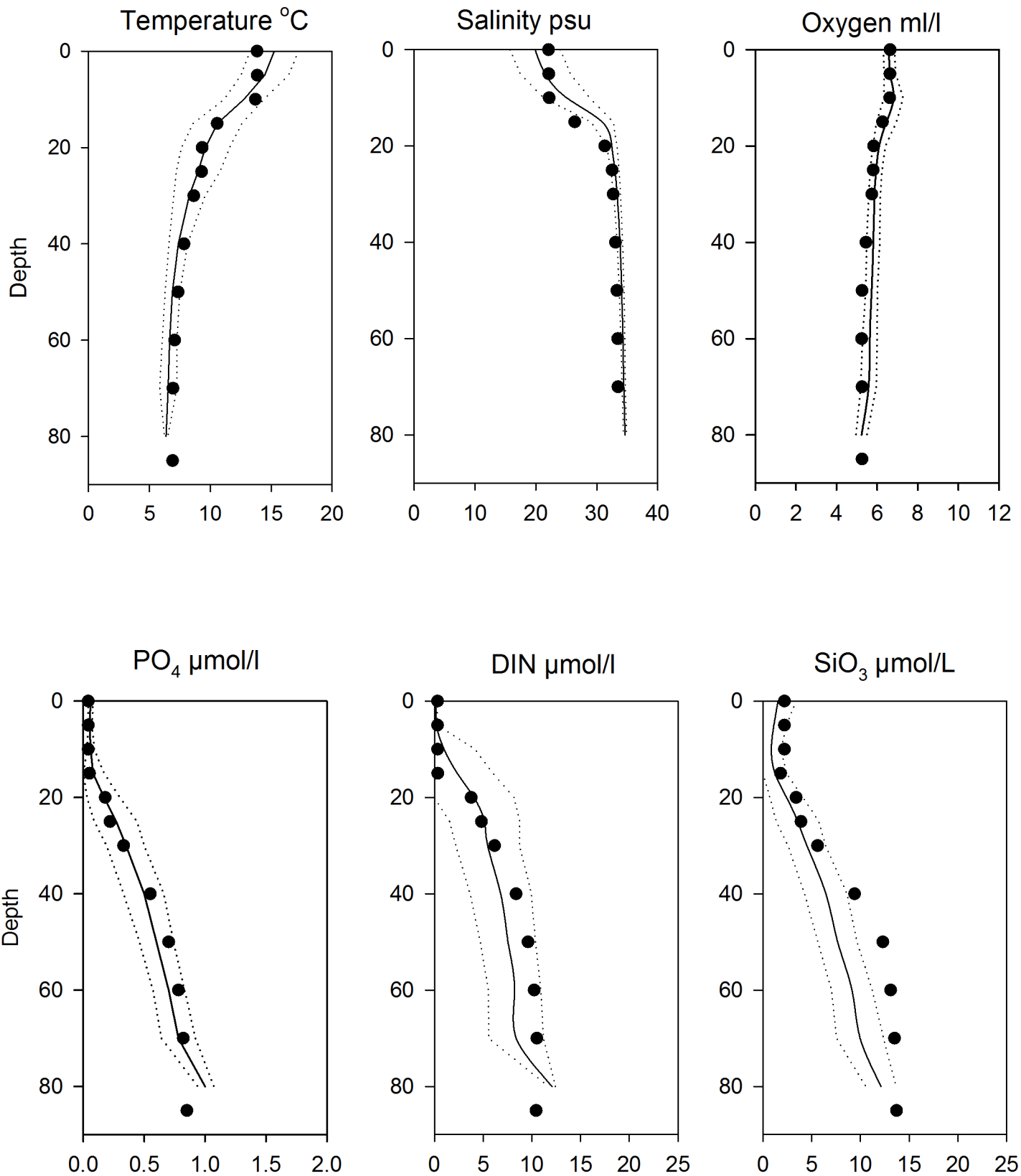


## OXYGEN IN BOTTOM WATER (depth > 70m)



# Vertical profiles Fladen June

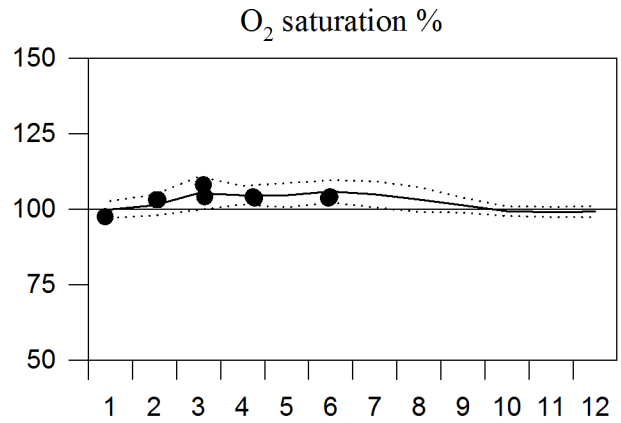
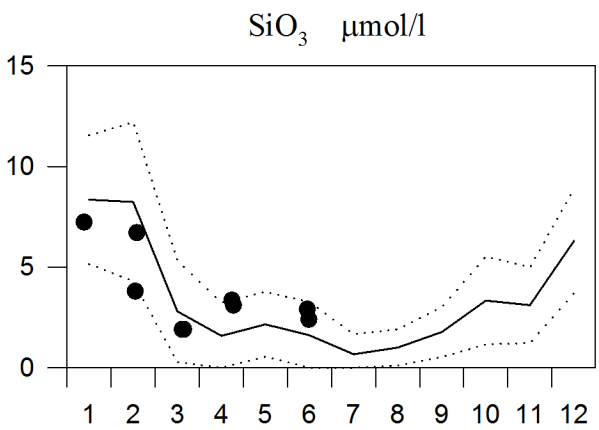
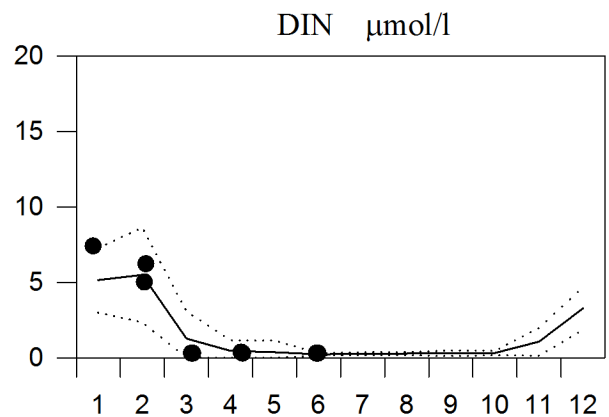
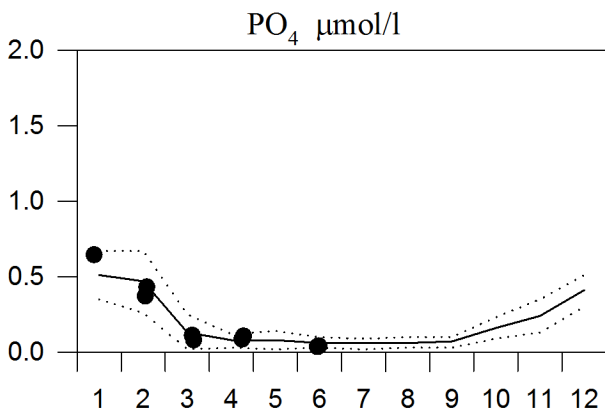
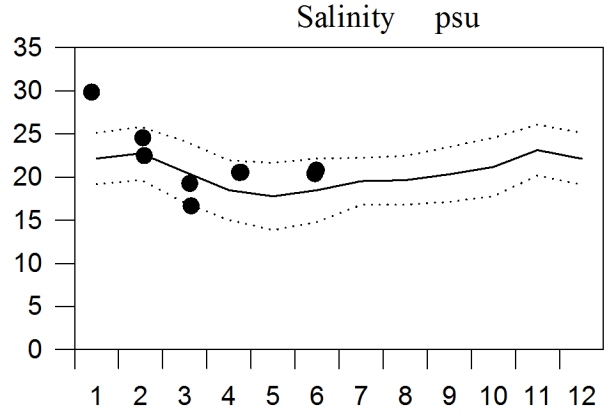
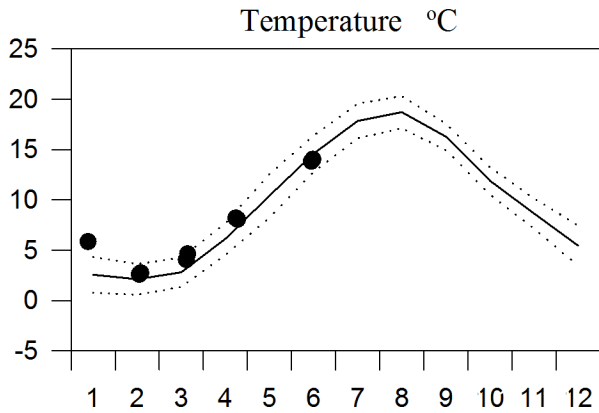
— Mean 1996-2010      ..... St.Dev.      ● 2015



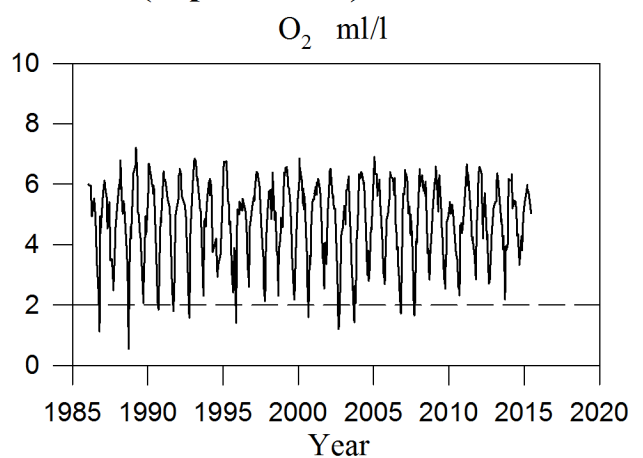
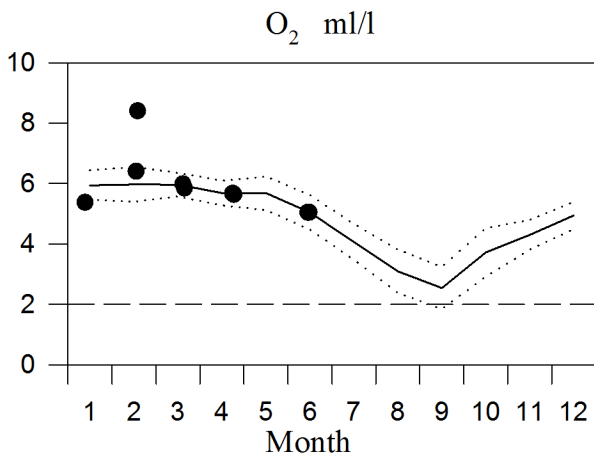
# STATION ANHOLT E SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

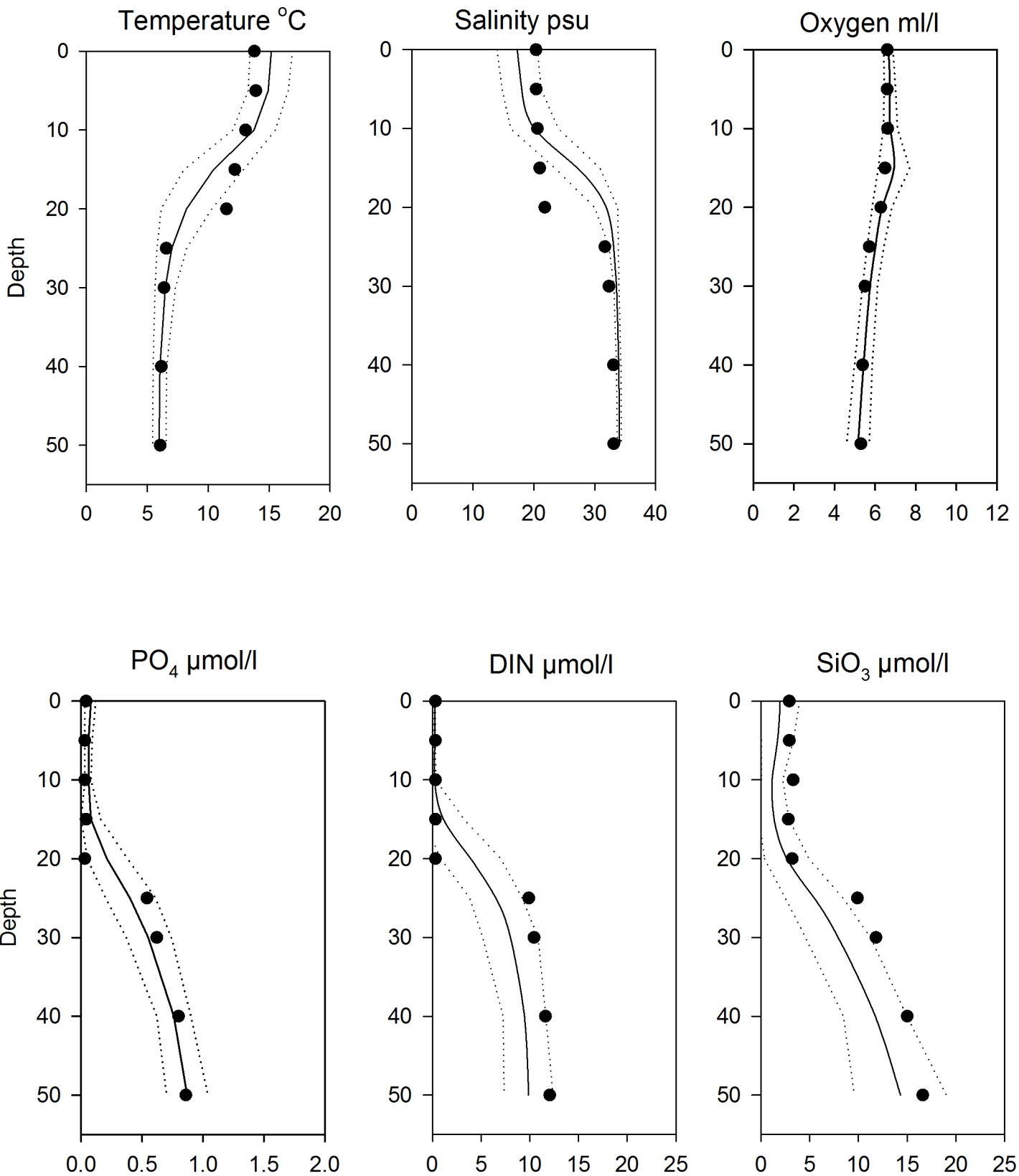


## OXYGEN IN BOTTOM WATER (depth > 50m)



# Vertical profiles Anholt E June

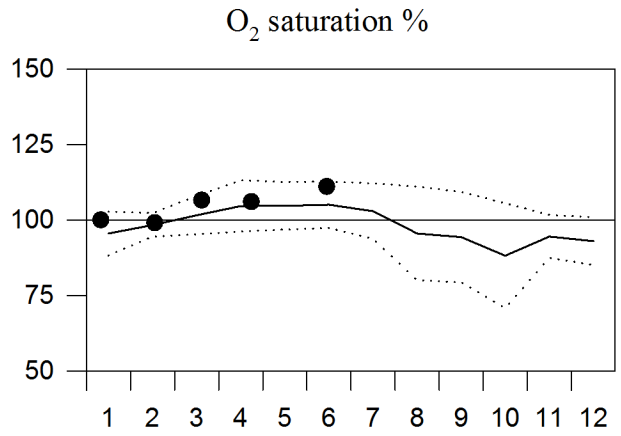
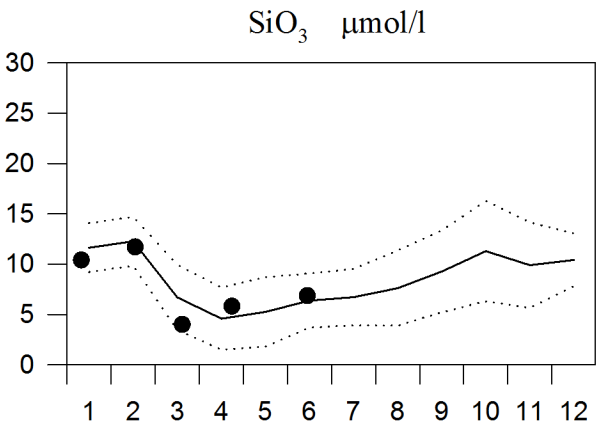
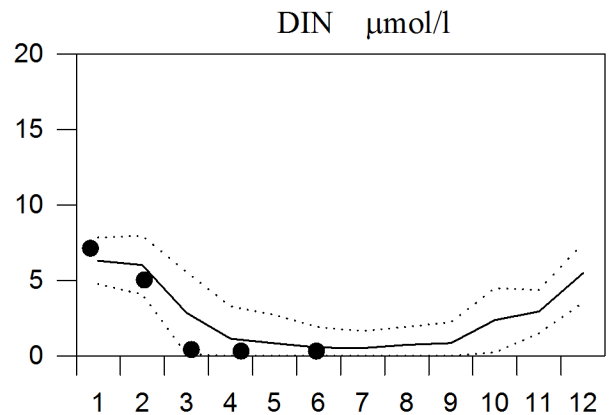
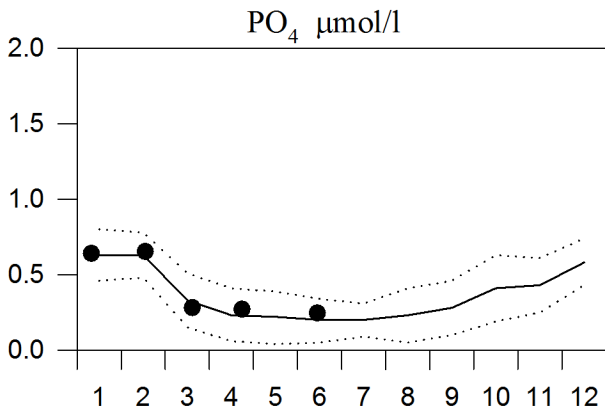
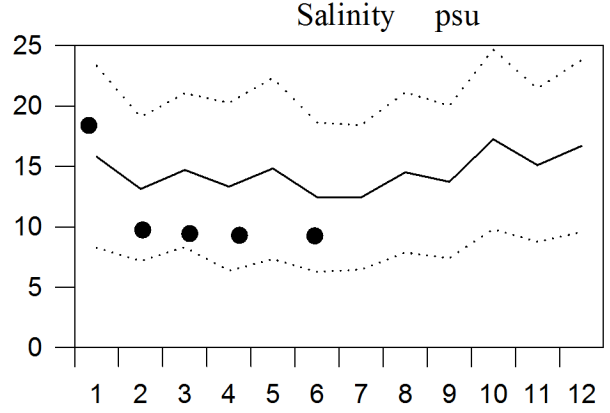
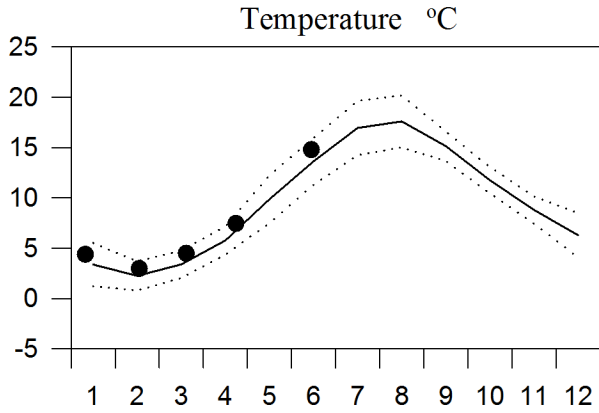
— Mean 1996-2010      ..... St.Dev.      ● 2015



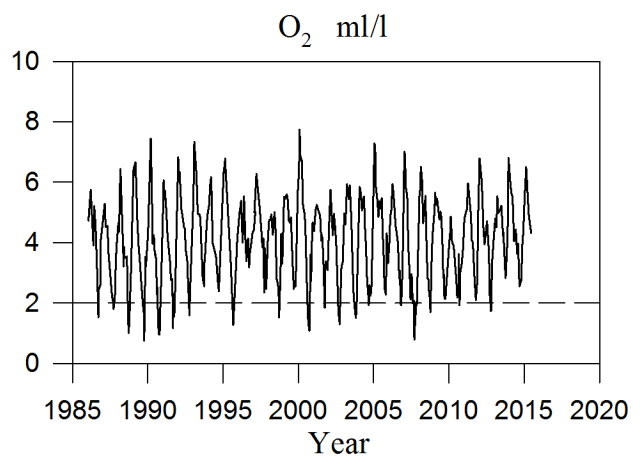
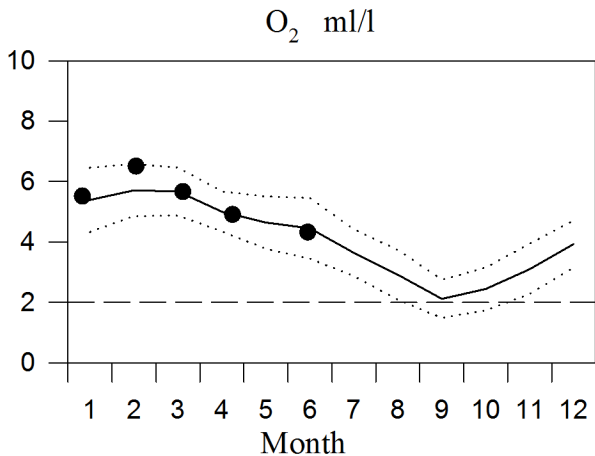
# STATION W LANDSKRONA SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

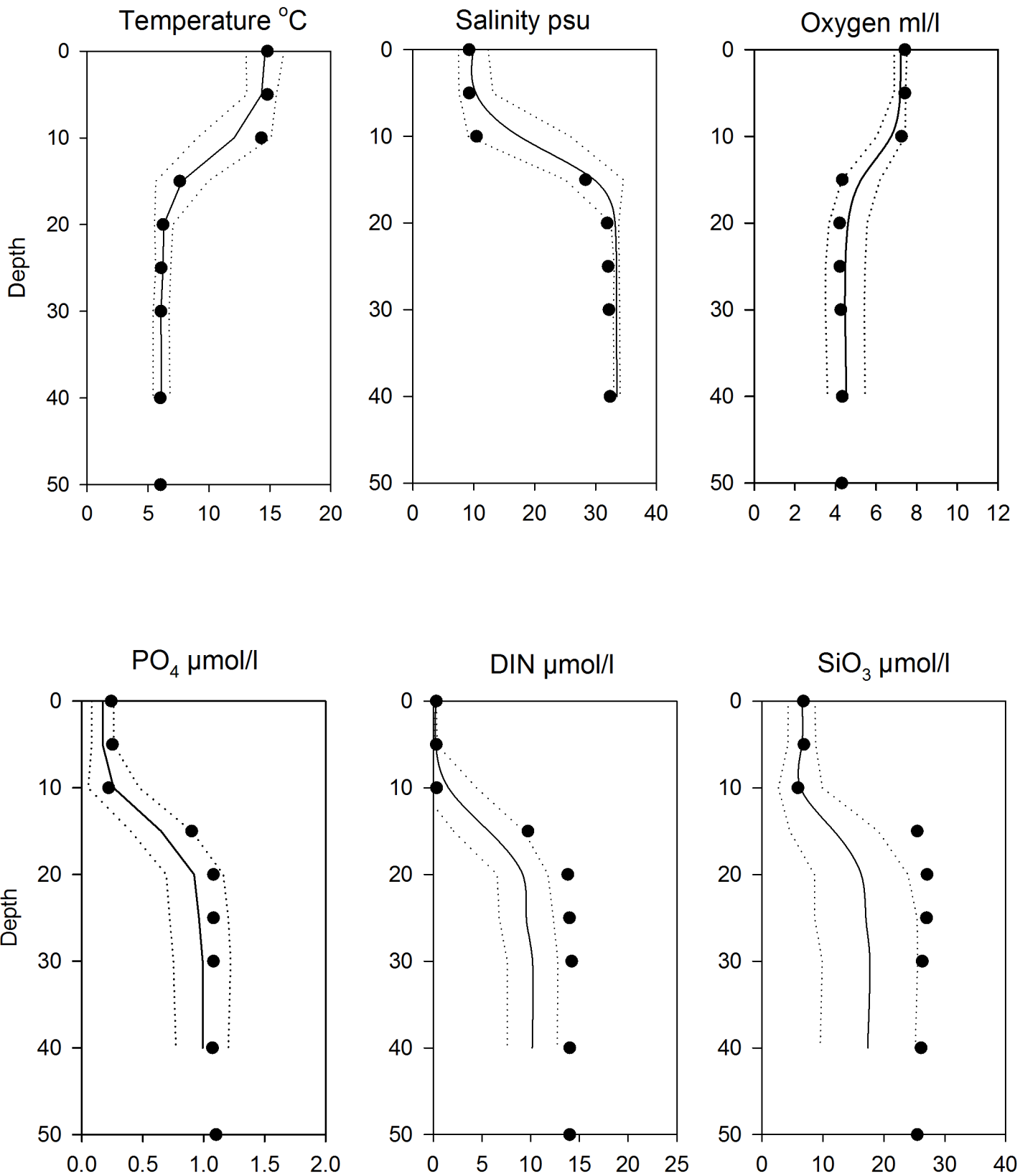


## OXYGEN IN BOTTOM WATER (depth >40m)



# Vertical profiles W Landskrona June

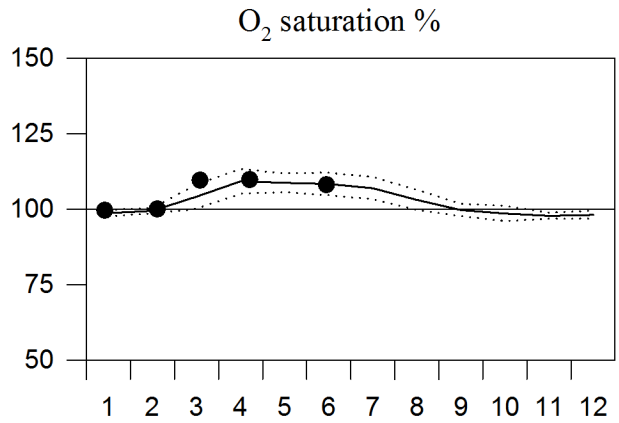
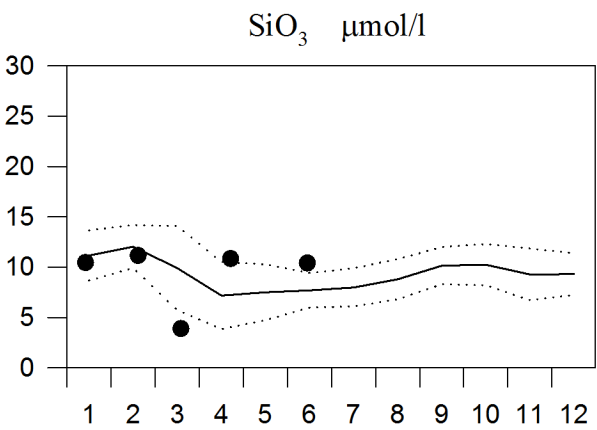
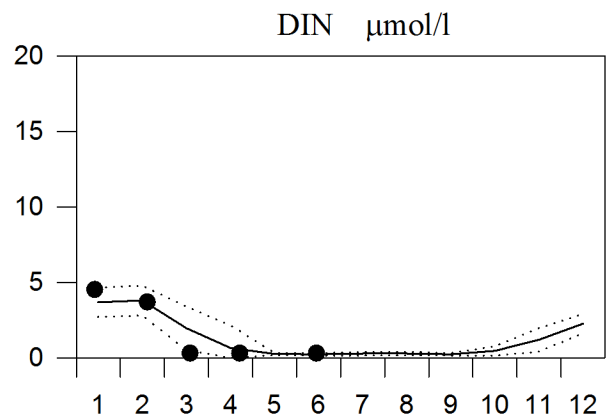
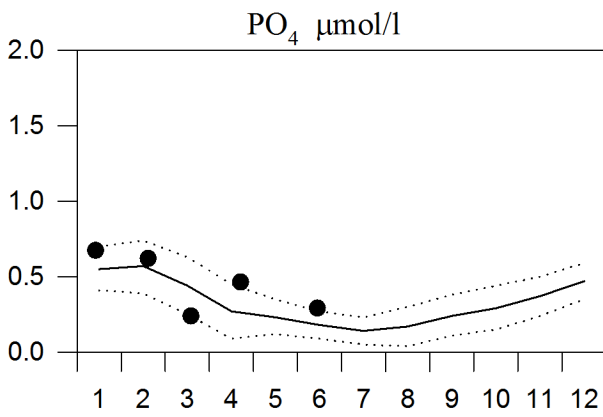
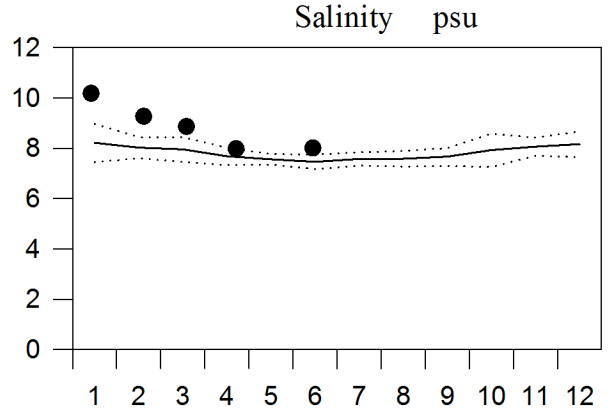
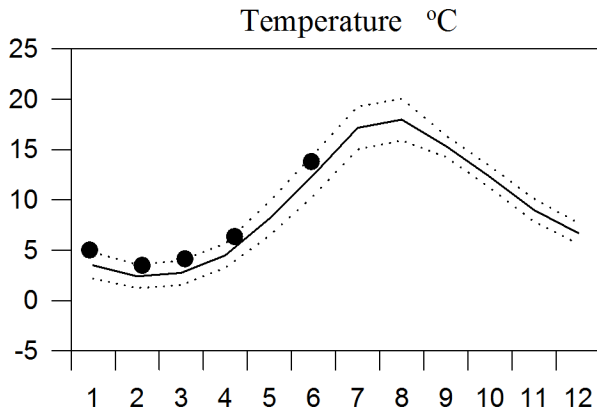
— Mean 1996-2010      ..... St.Dev.      ● 2015



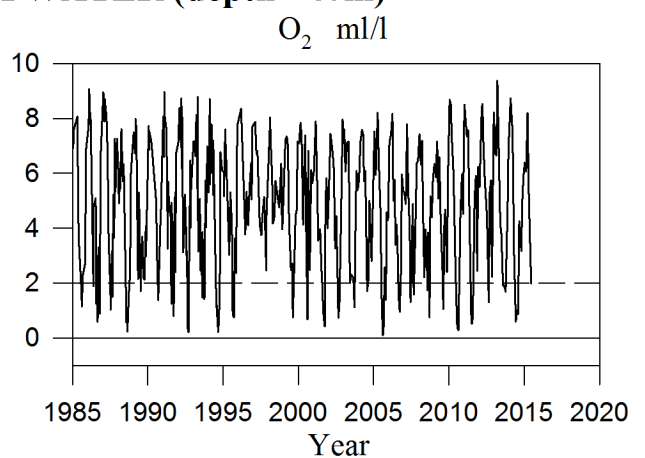
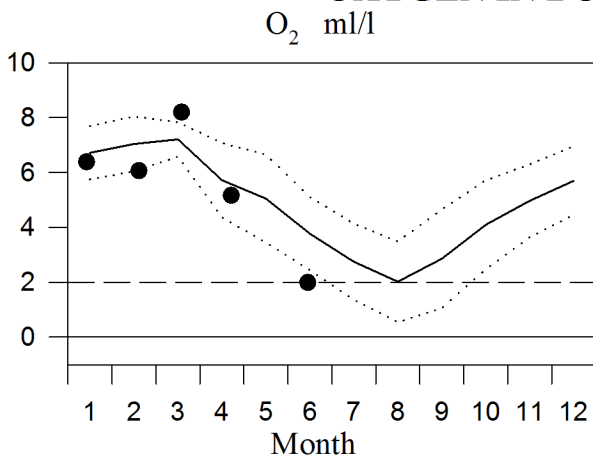
# STATION BY1 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015



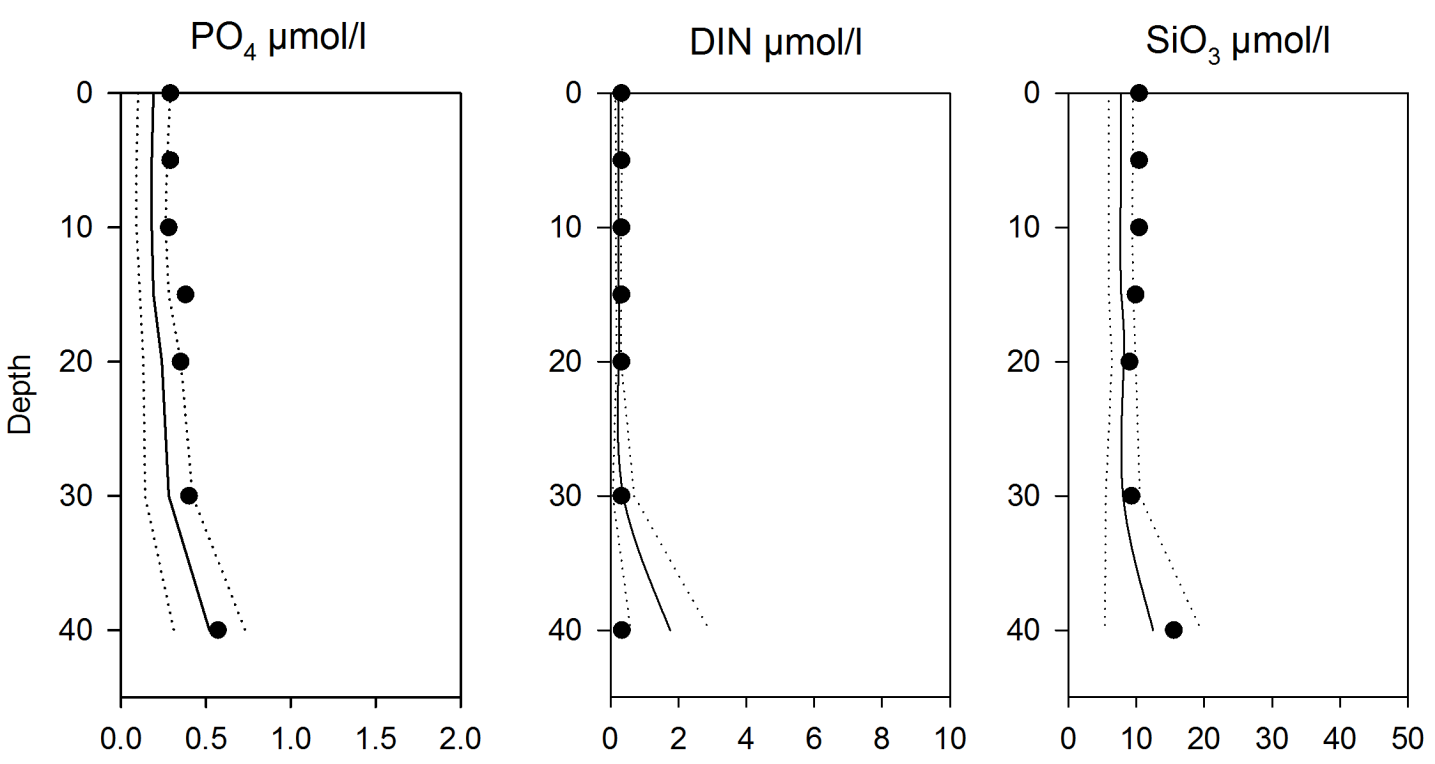
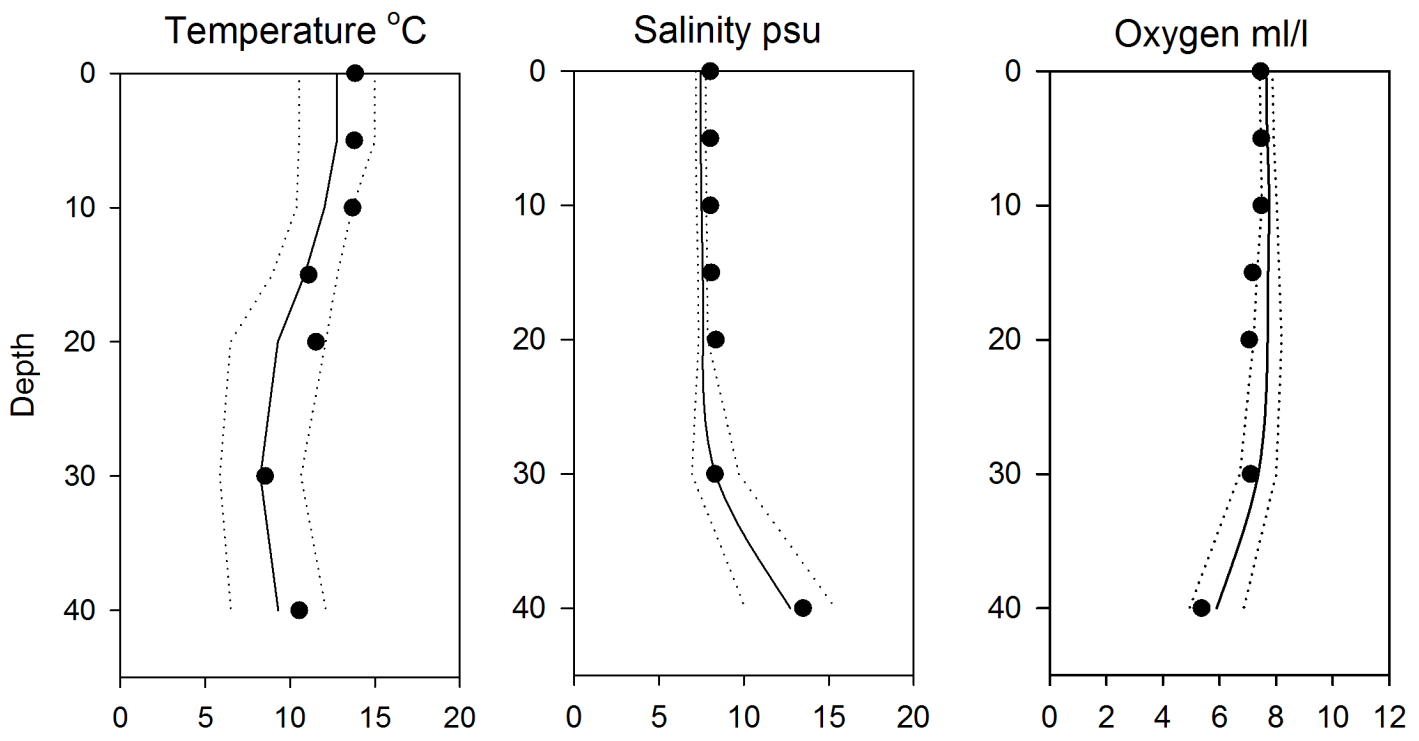
## OXYGEN IN BOTTOM WATER (depth >40m)





# Vertical profiles BY1 June

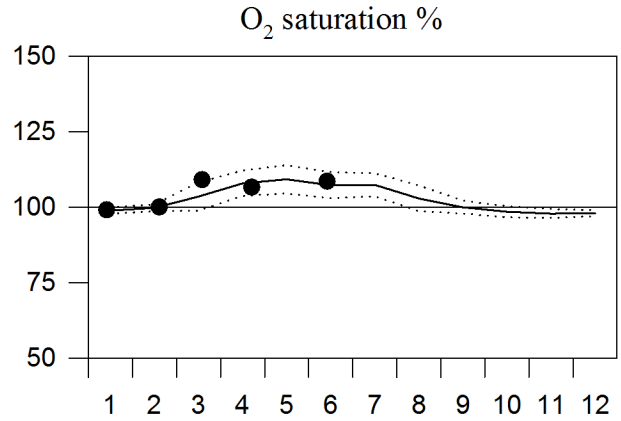
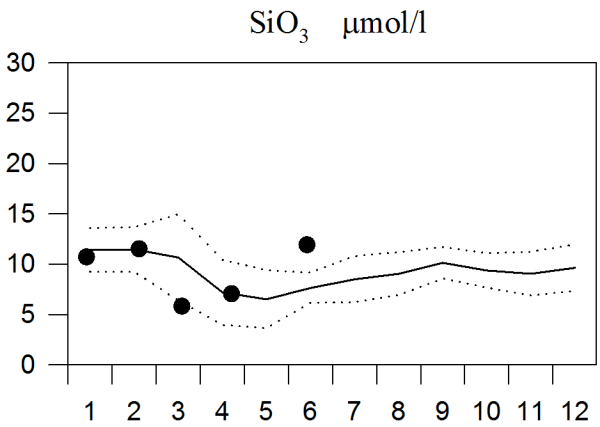
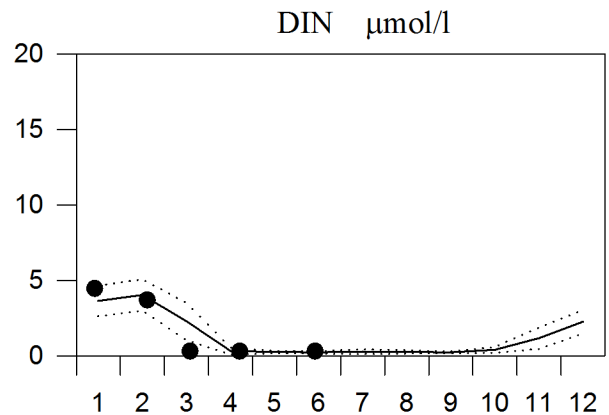
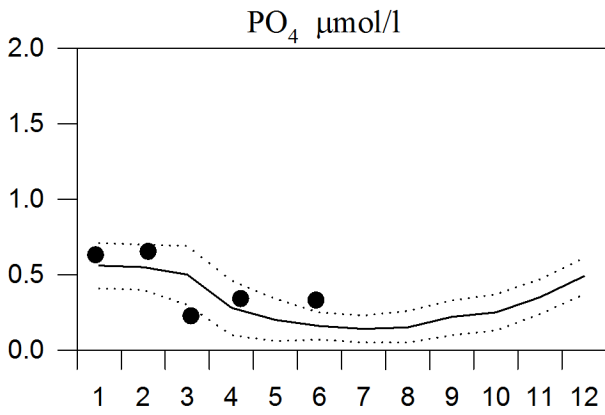
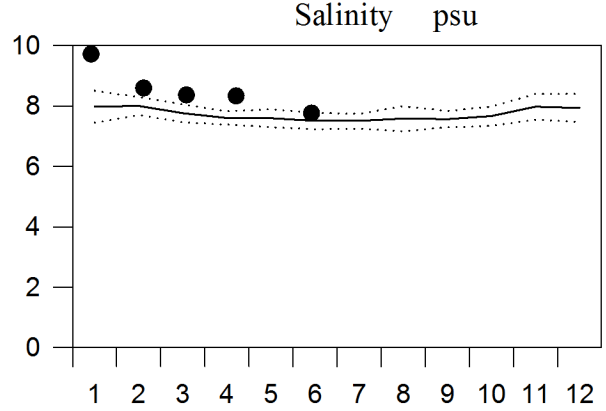
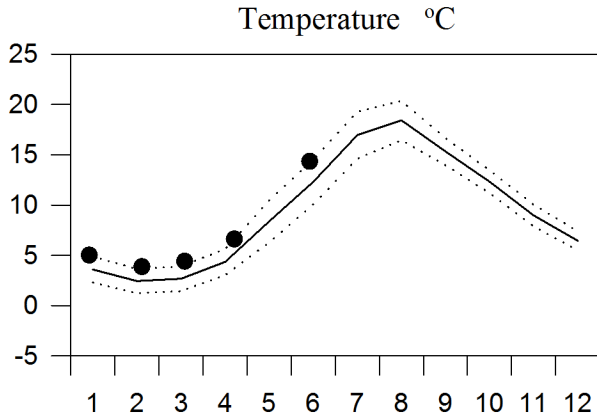
— Mean 1996-2010      ····· St.Dev.      ● 2015



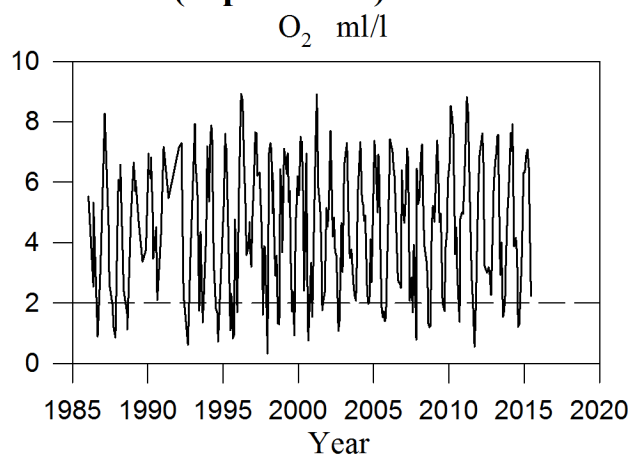
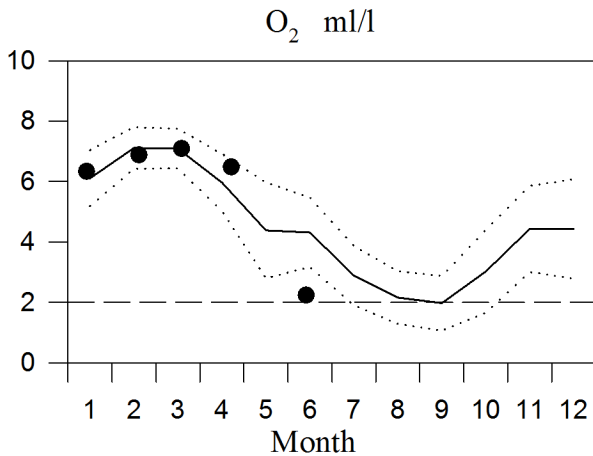
# STATION BY2 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ····· St.Dev.      ● 2015

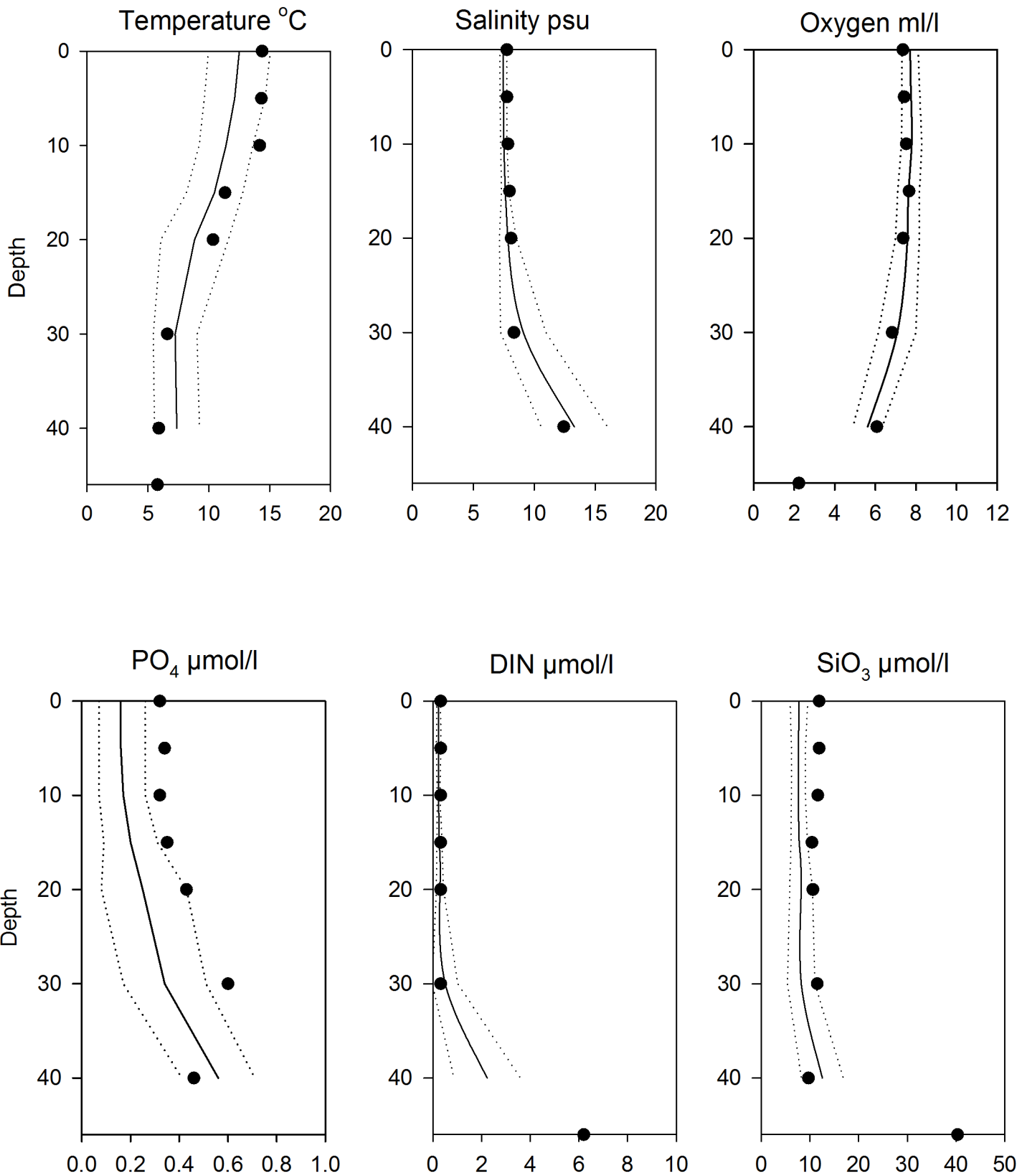


## OXYGEN IN BOTTOM WATER (depth >40m)



# Vertical profiles BY2 June

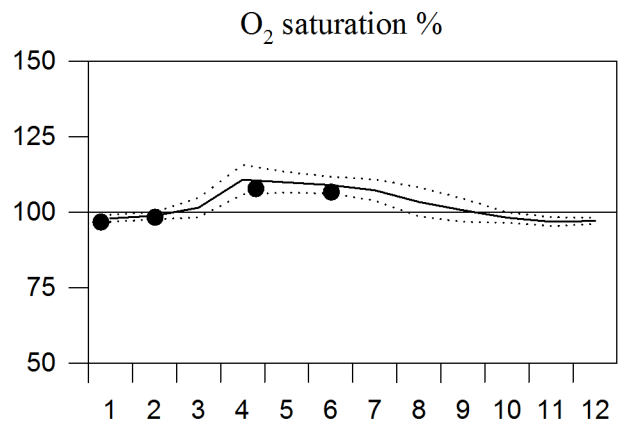
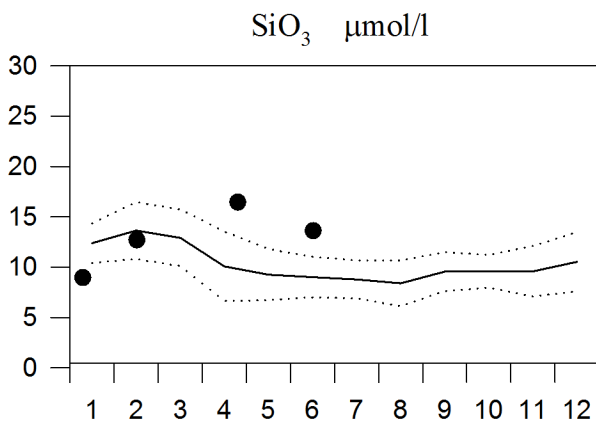
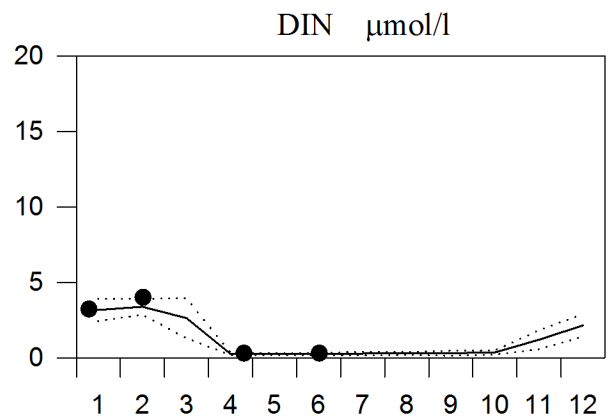
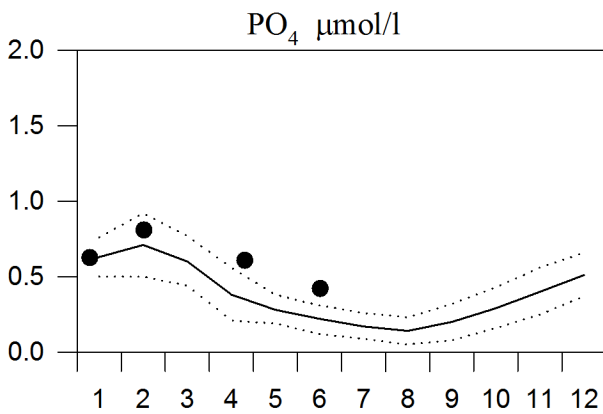
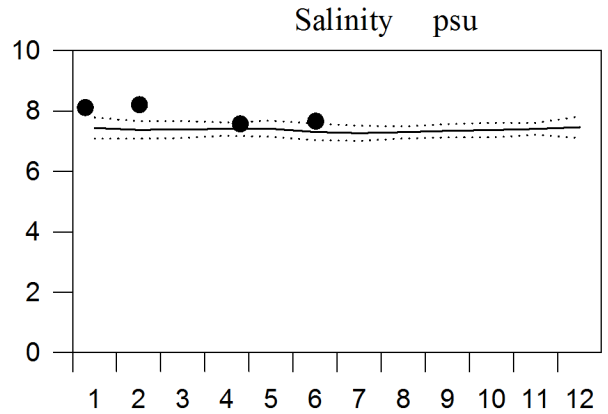
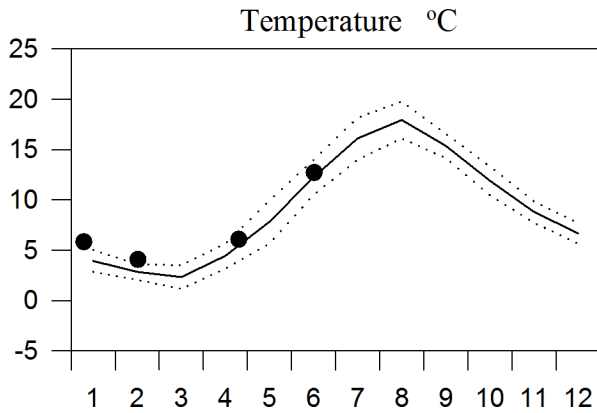
— Mean 1996-2010      ····· St.Dev.      ● 2015



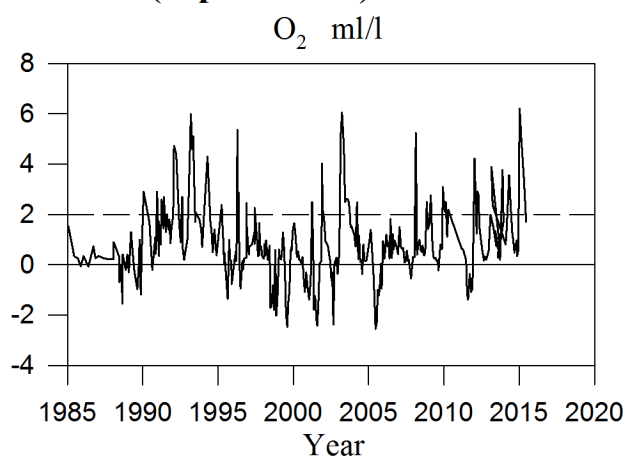
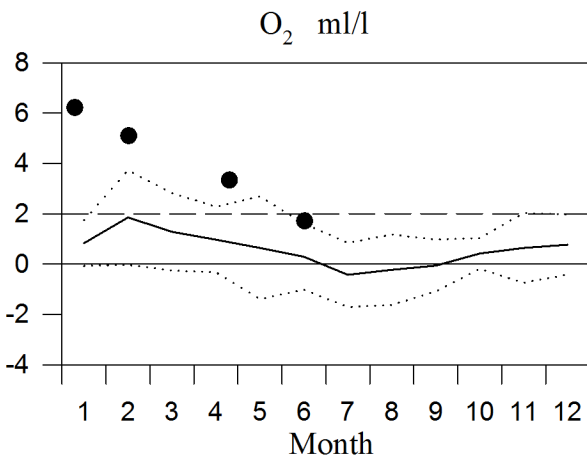
# STATION HANÖBUKTEN SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

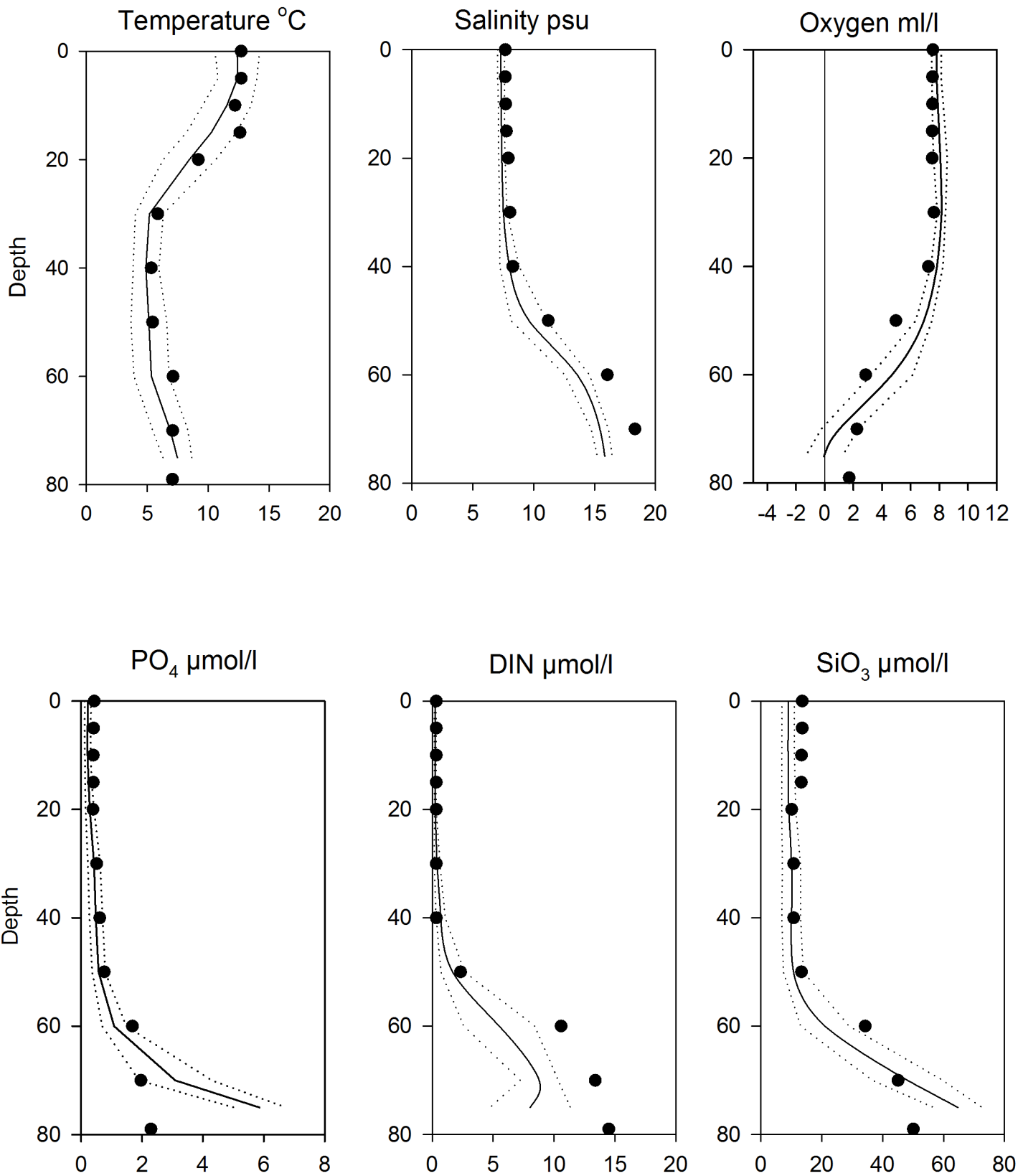


## OXYGEN IN BOTTOM WATER (depth > 70m)



# Vertical profiles Hanöbukten June

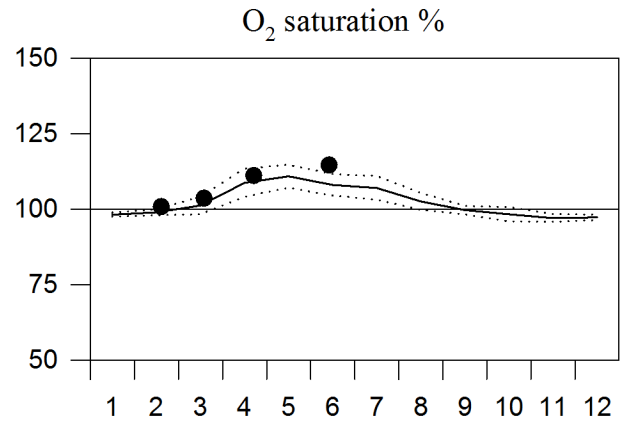
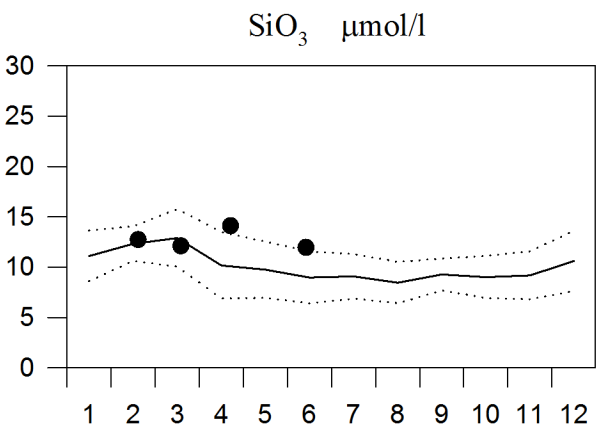
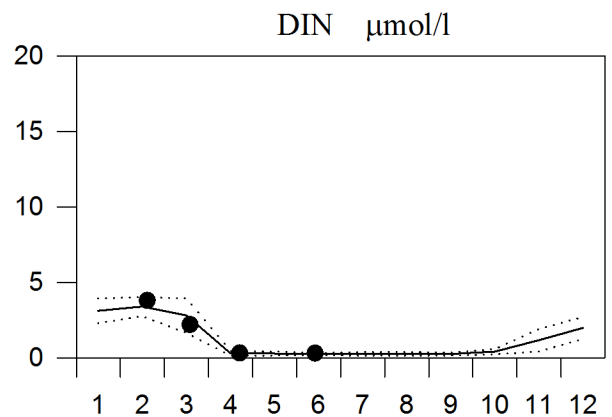
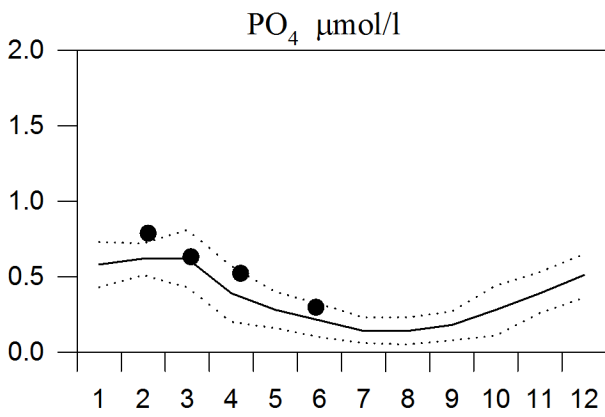
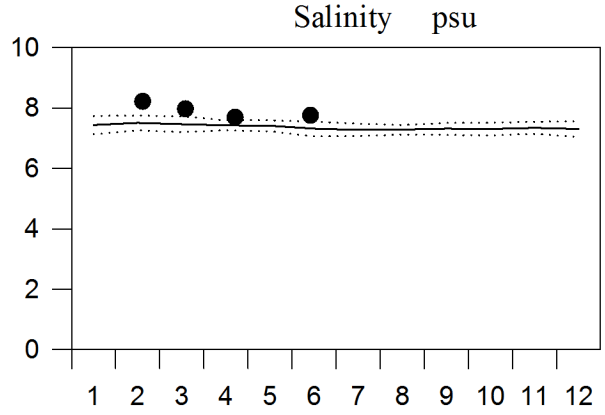
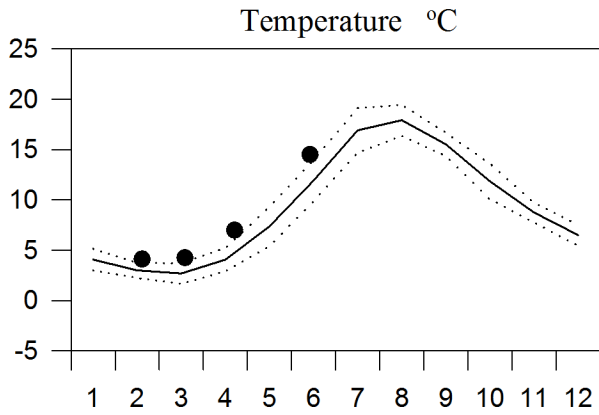
— Mean 1996-2010      ····· St.Dev.      ● 2015



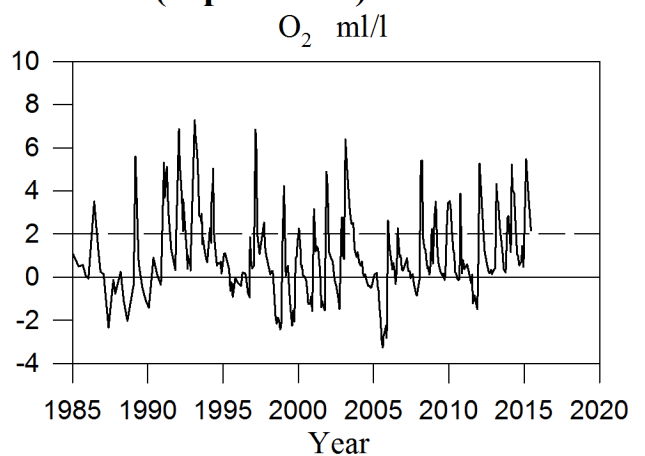
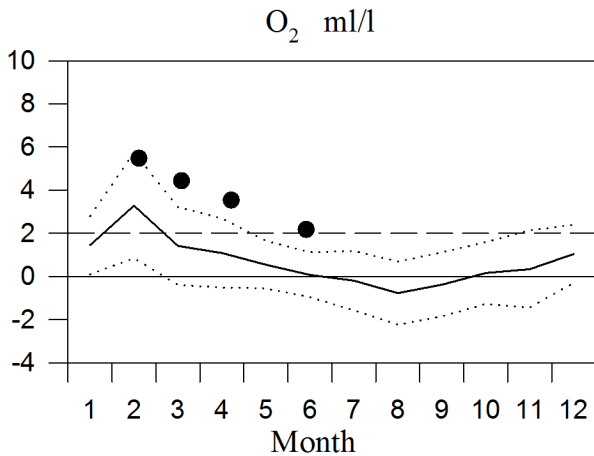
# STATION BY4 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ····· St.Dev.      ● 2015

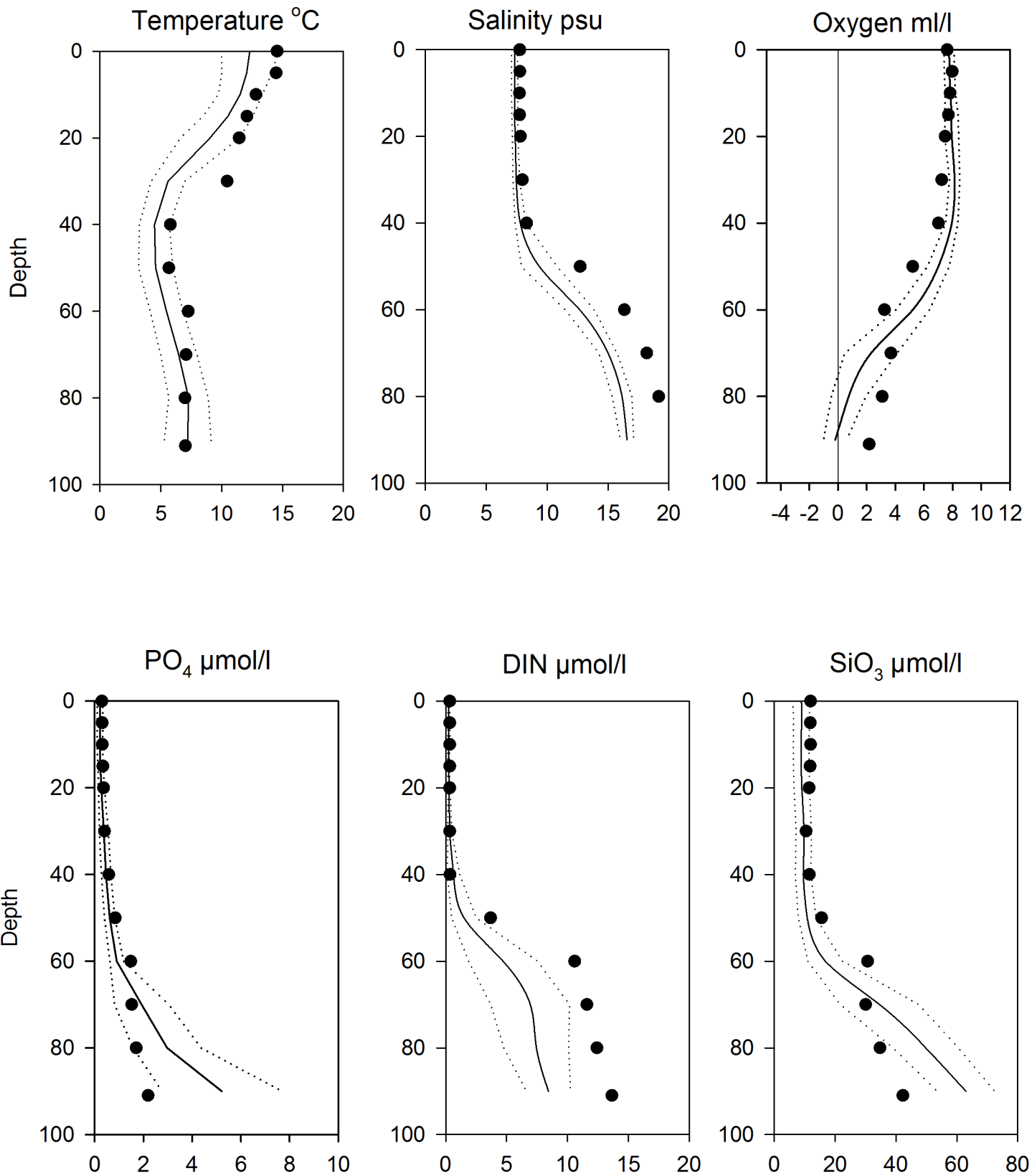


## OXYGEN IN BOTTOM WATER (depth >80m)



# Vertical profiles BY4 June

— Mean 1996-2010      ····· St.Dev.      ● 2015

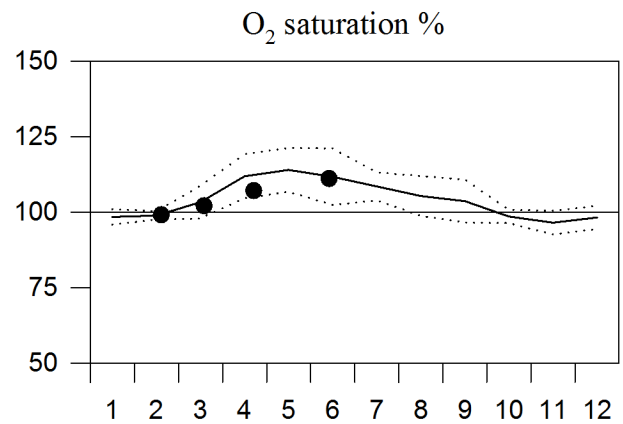
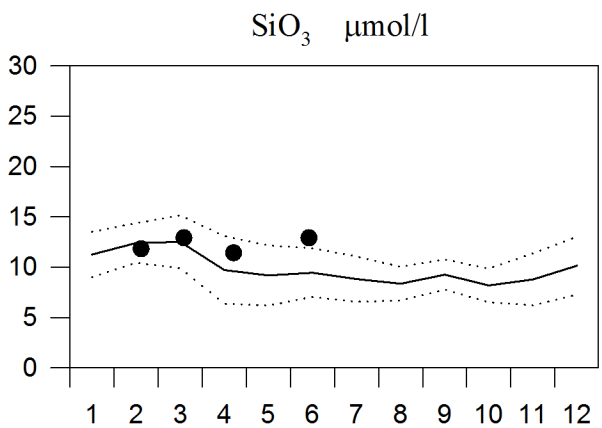
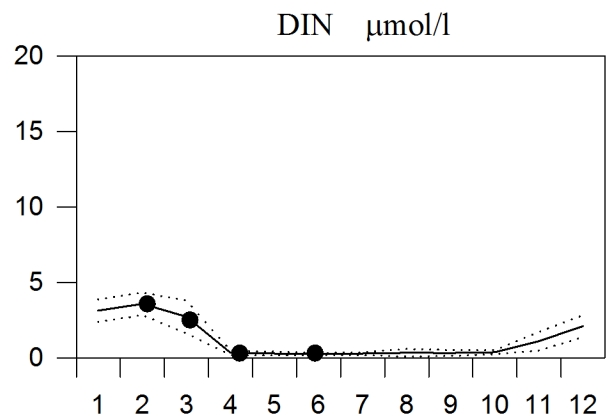
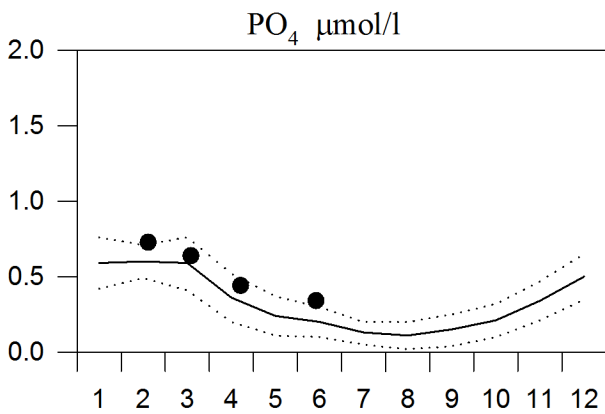
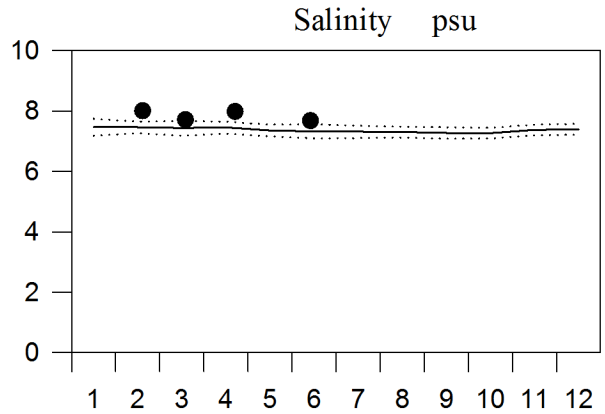
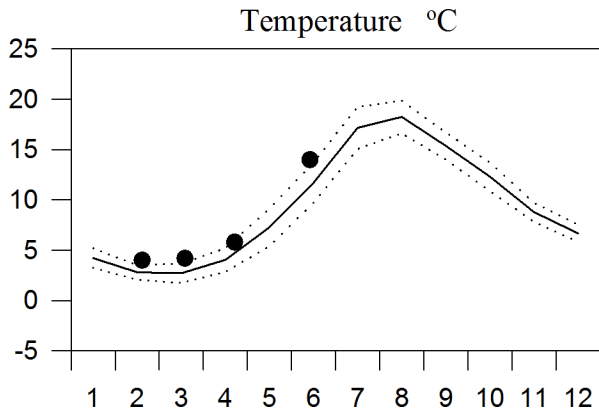




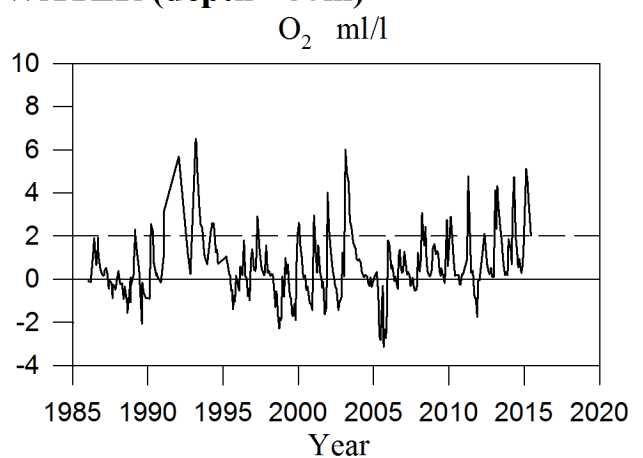
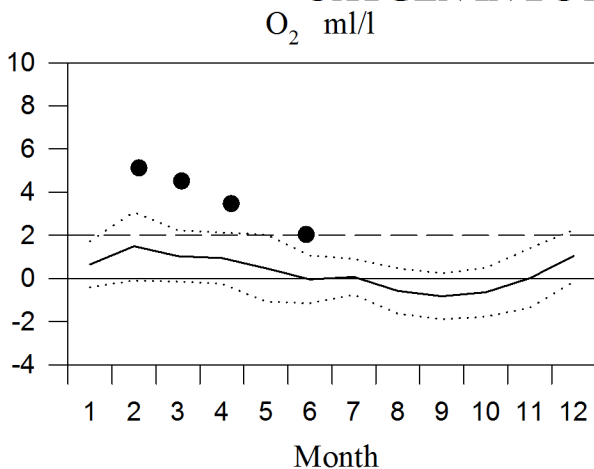
# STATION BY5 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ····· St.Dev.      ● 2015

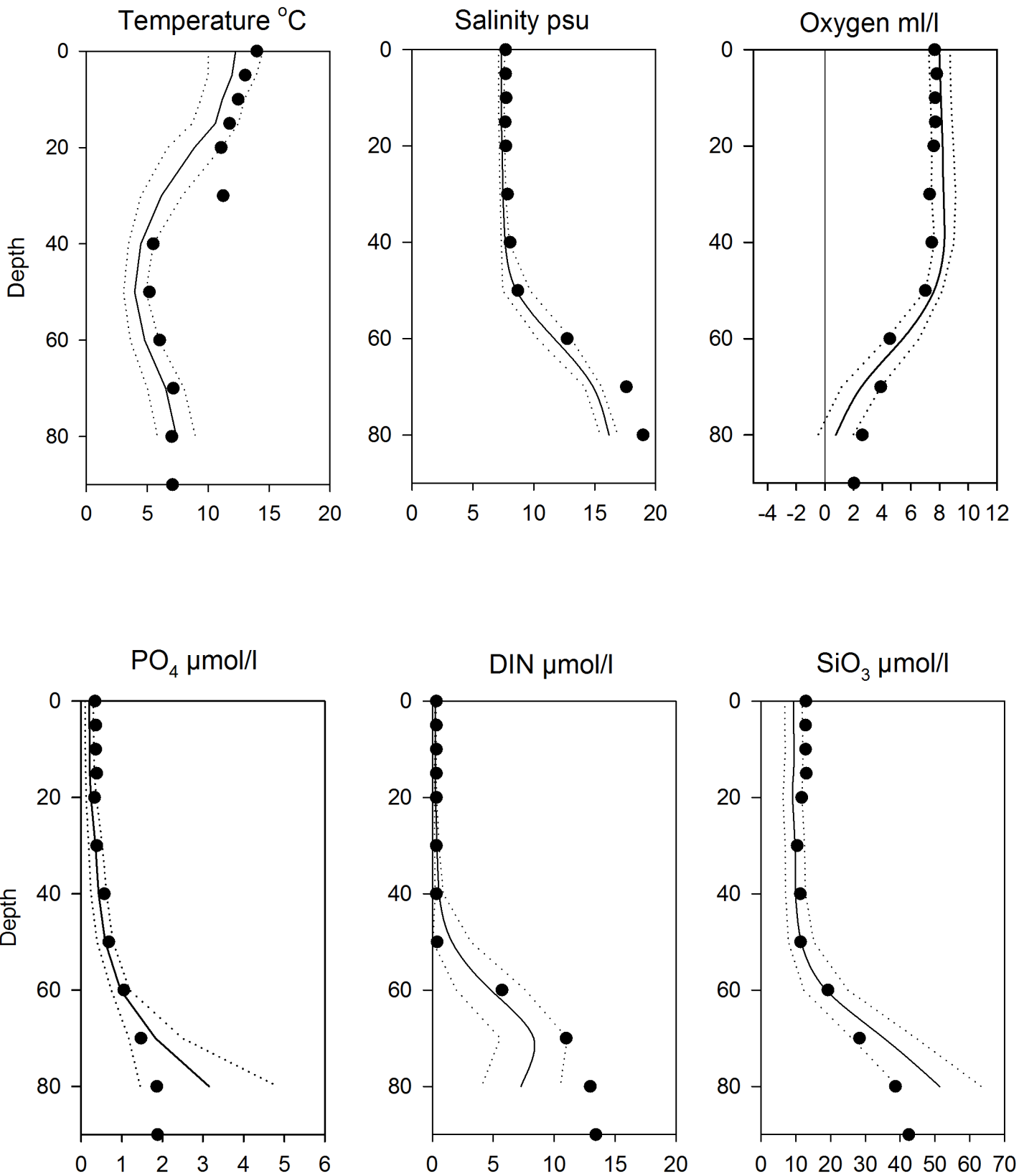


## OXYGEN IN BOTTOM WATER (depth >80m)



# Vertical profiles BY5 June

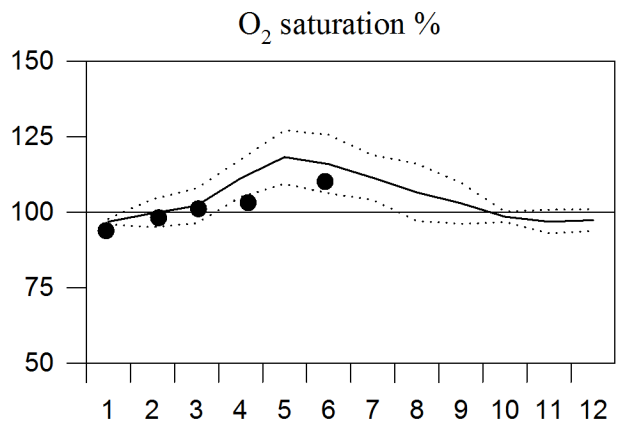
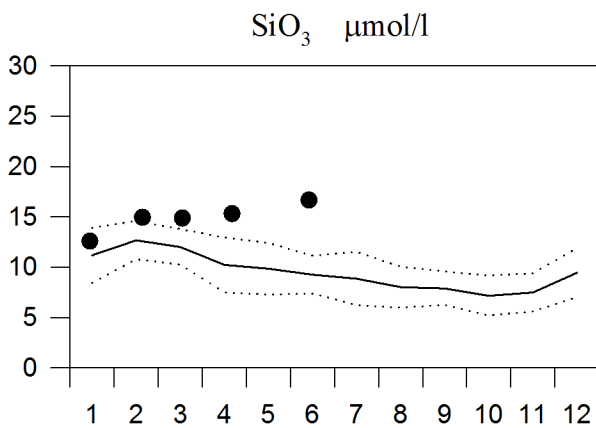
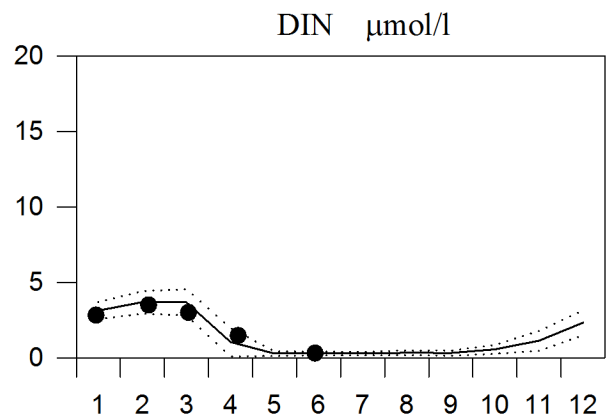
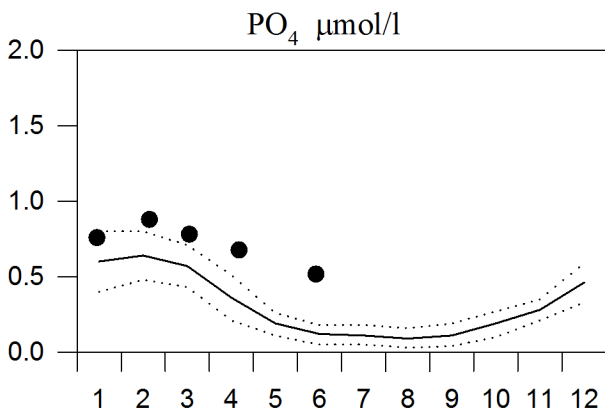
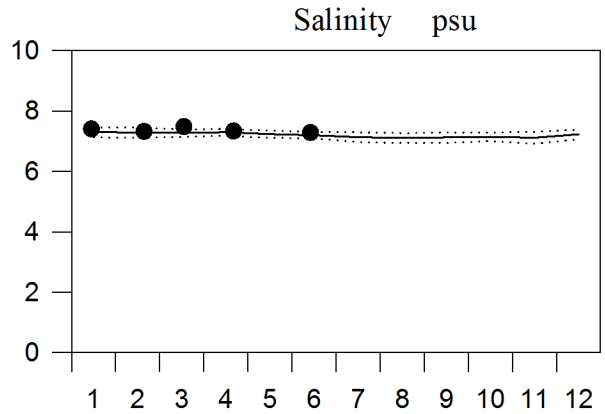
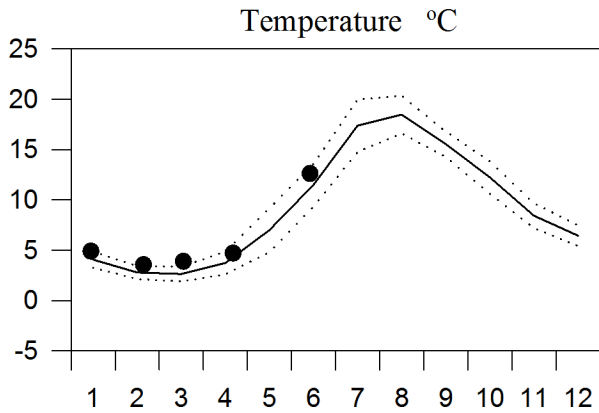
— Mean 1996-2010      ····· St.Dev.      ● 2015



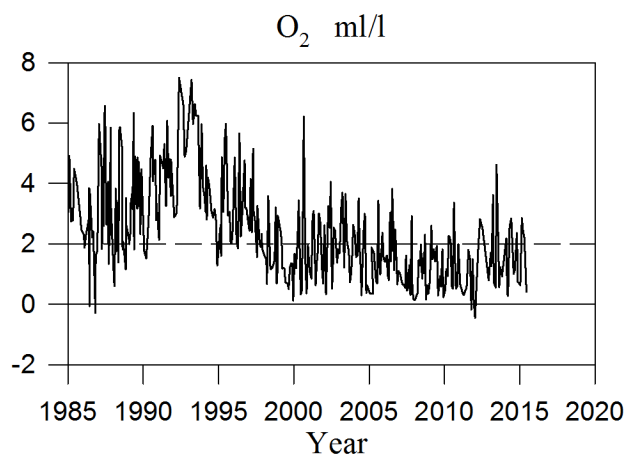
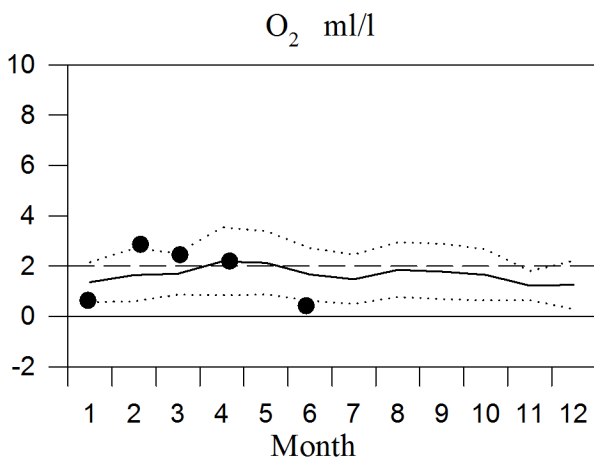
# STATION BCS III-10 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

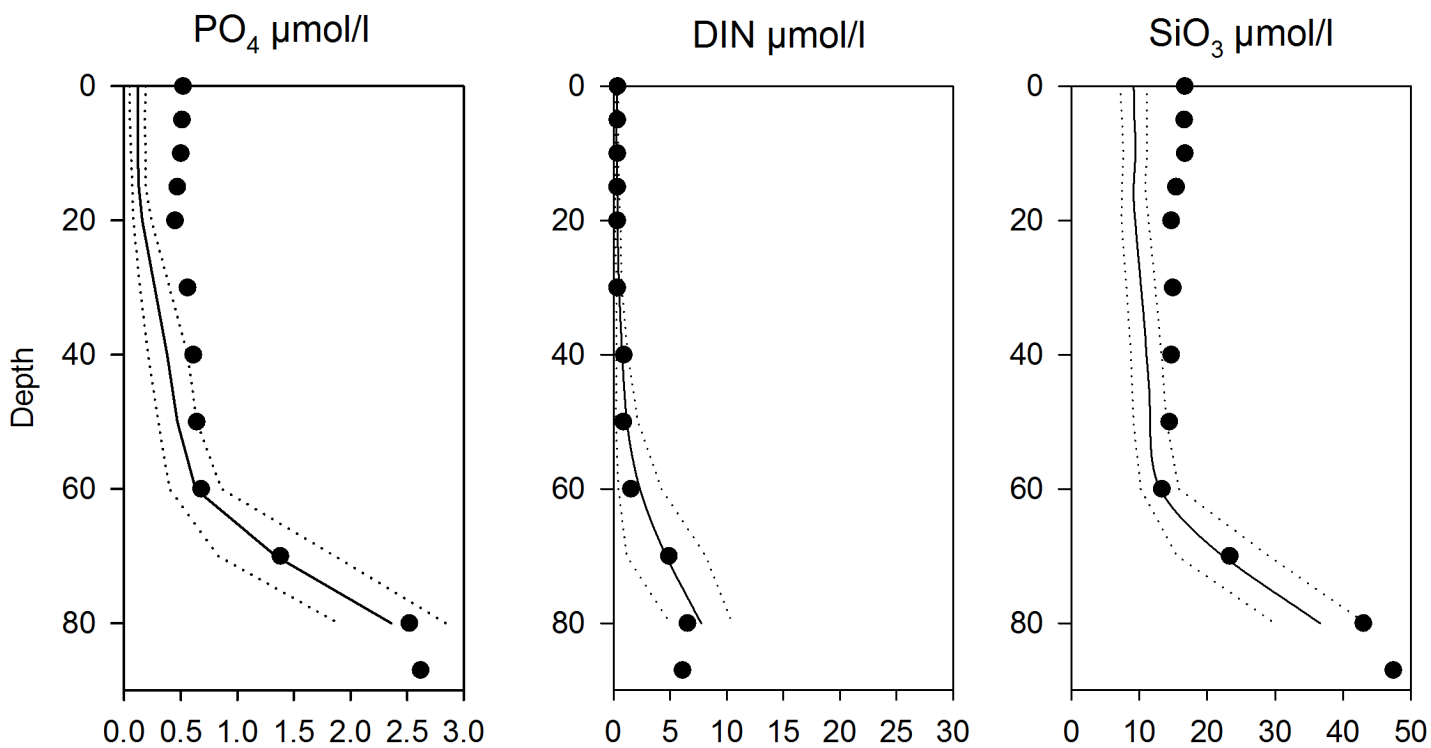
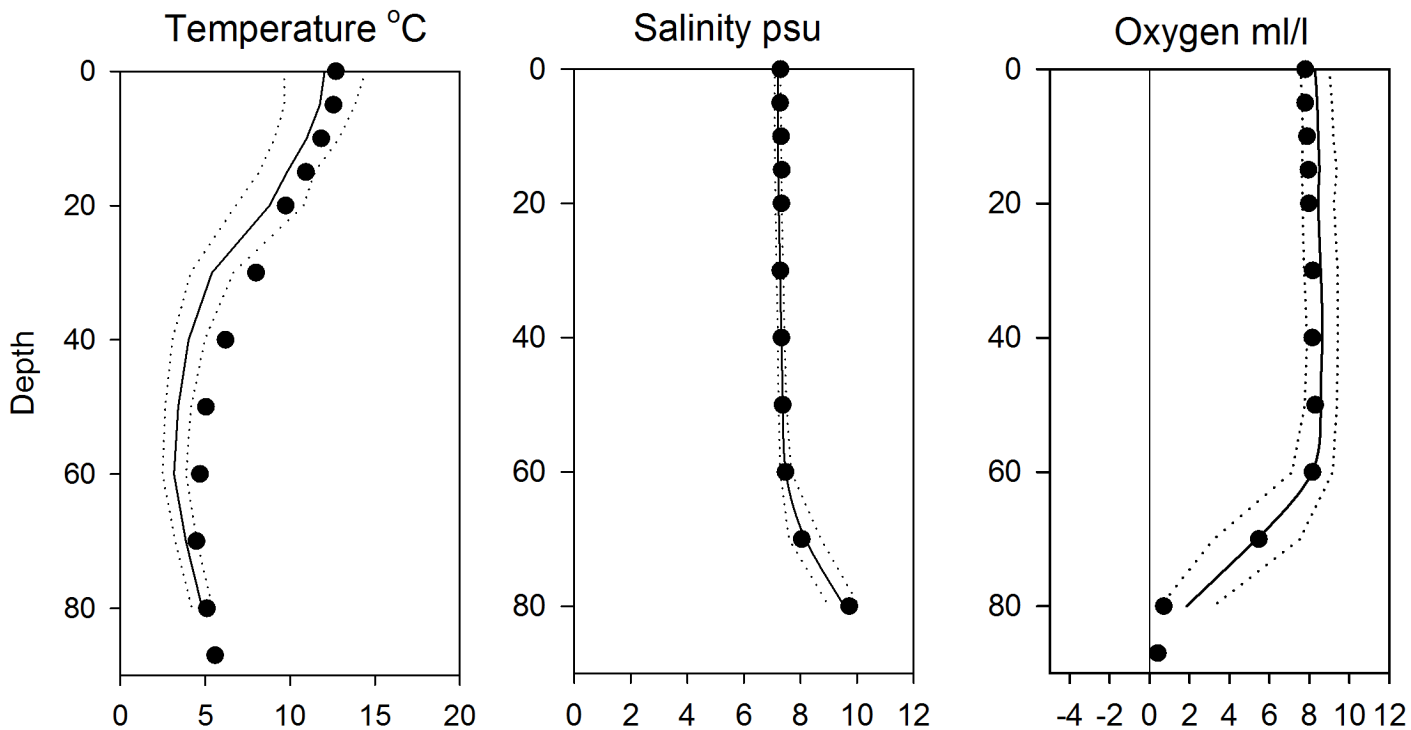


## OXYGEN IN BOTTOM WATER (depth > 80m)



# Vertical profiles BCS III-10 June

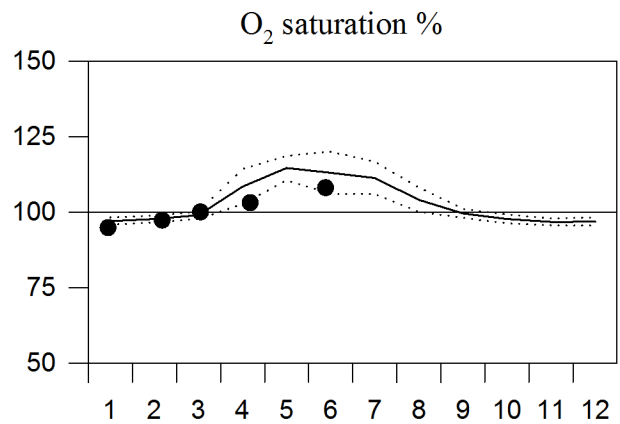
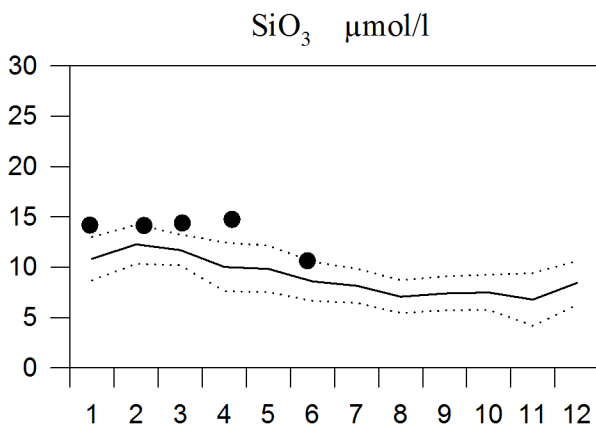
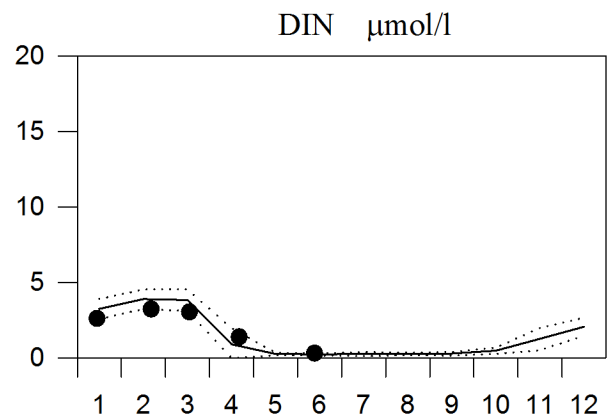
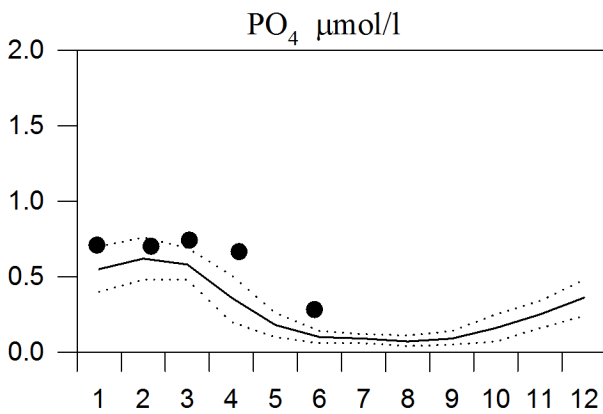
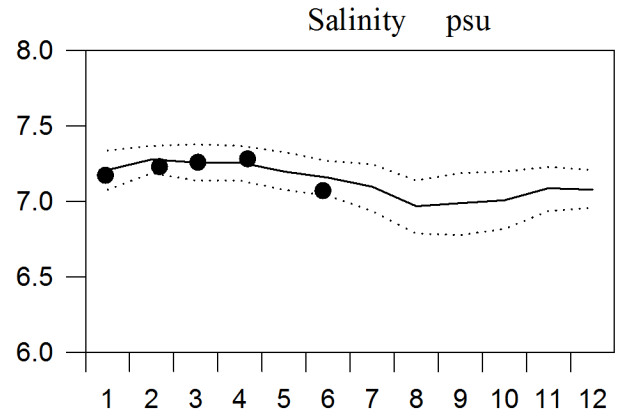
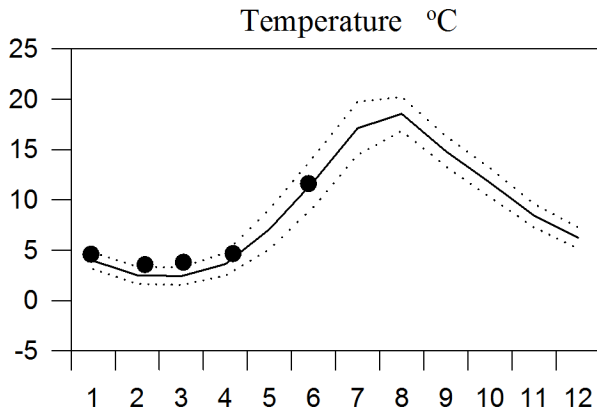
— Mean 1996-2010      ····· St.Dev.      ● 2015



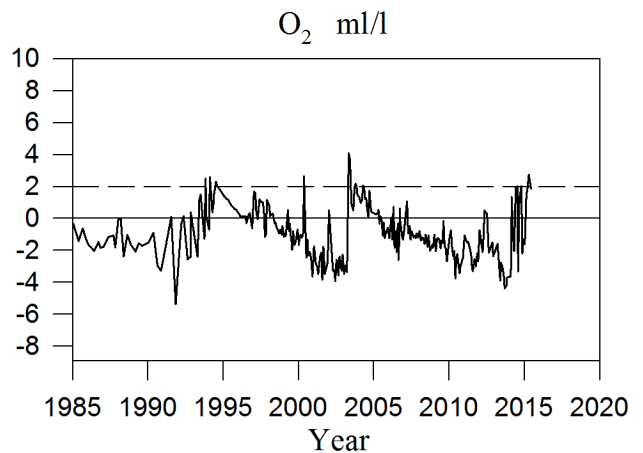
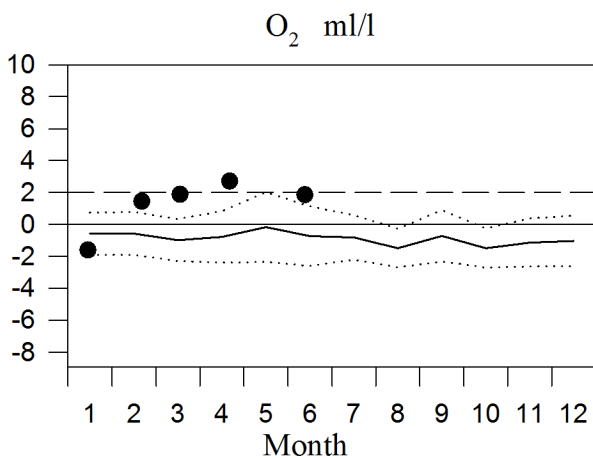
# STATION BY10 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

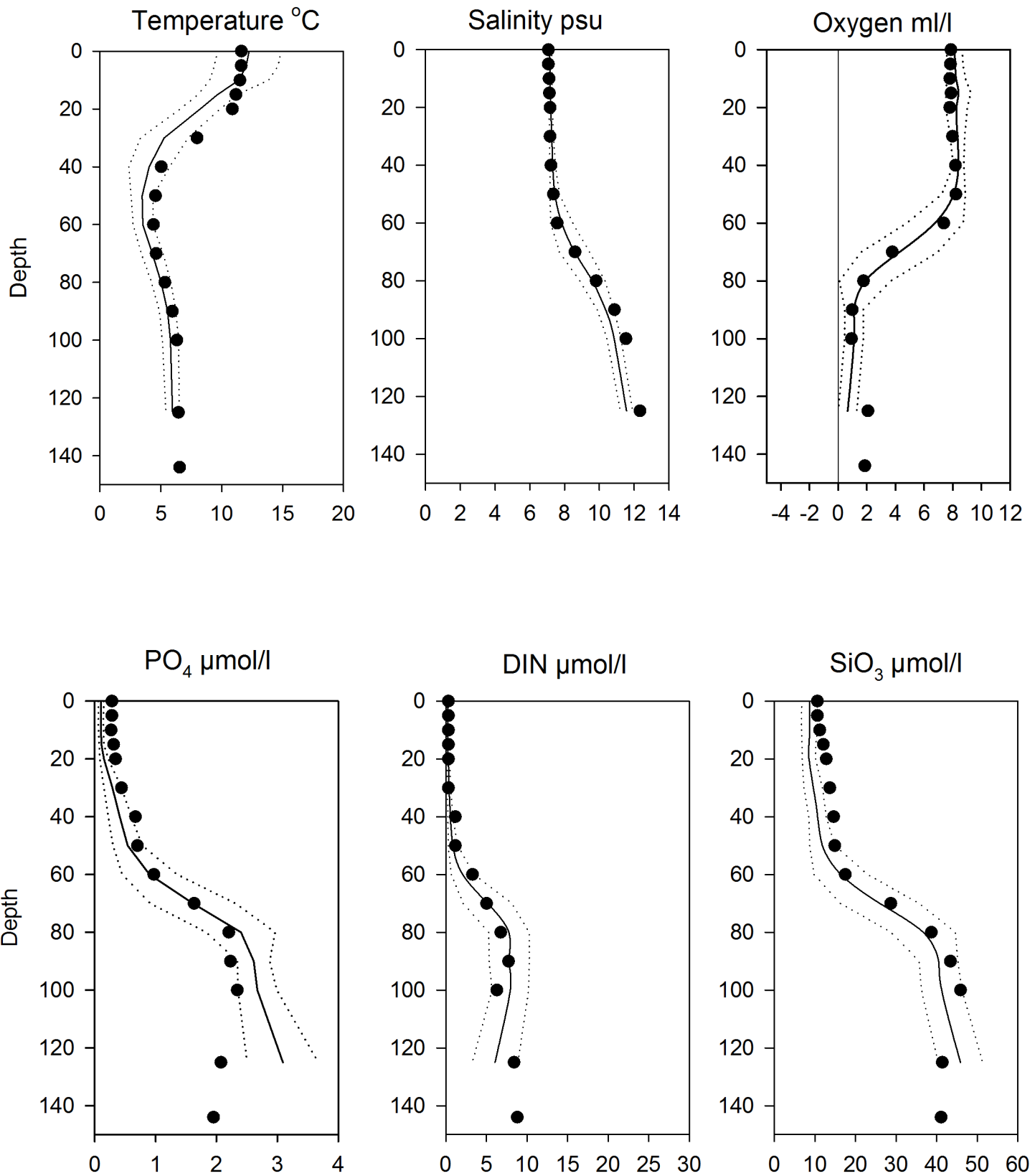


## OXYGEN IN BOTTOM WATER (depth >125m)



# Vertical profiles BY10 June

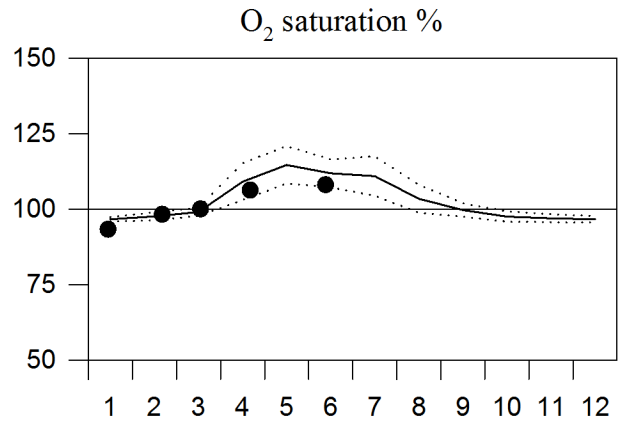
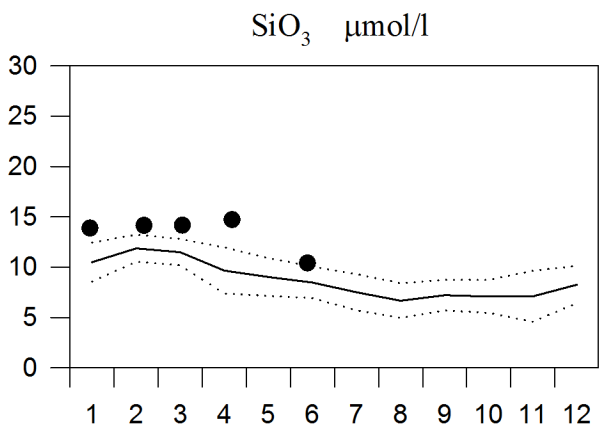
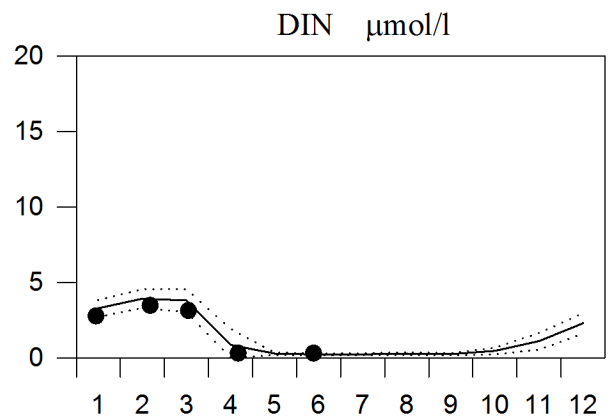
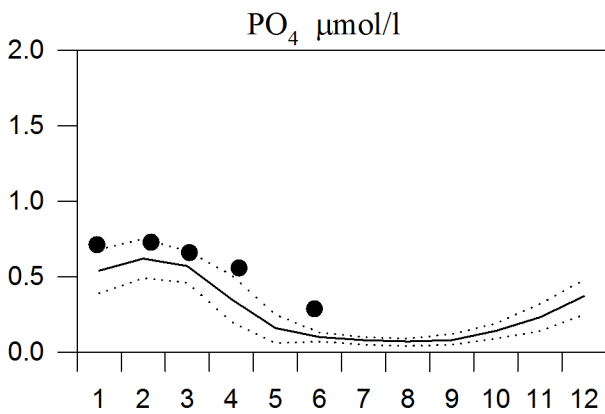
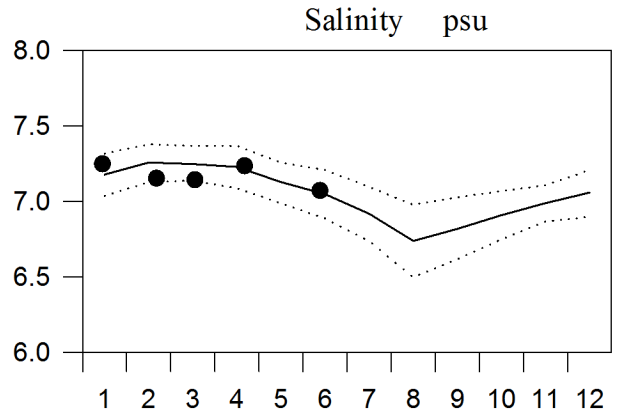
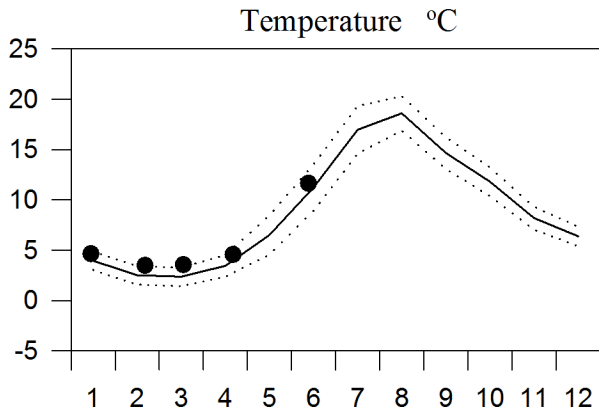
— Mean 1996-2010      ····· St.Dev.      ● 2015



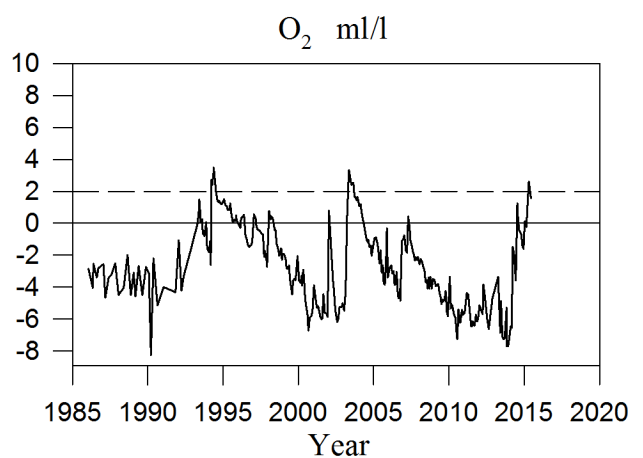
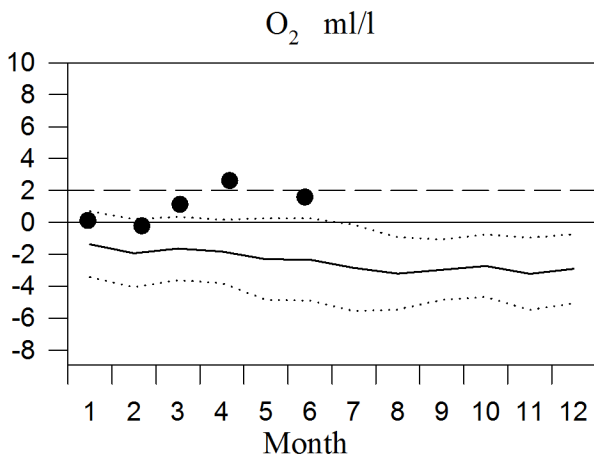
# STATION BY15 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015



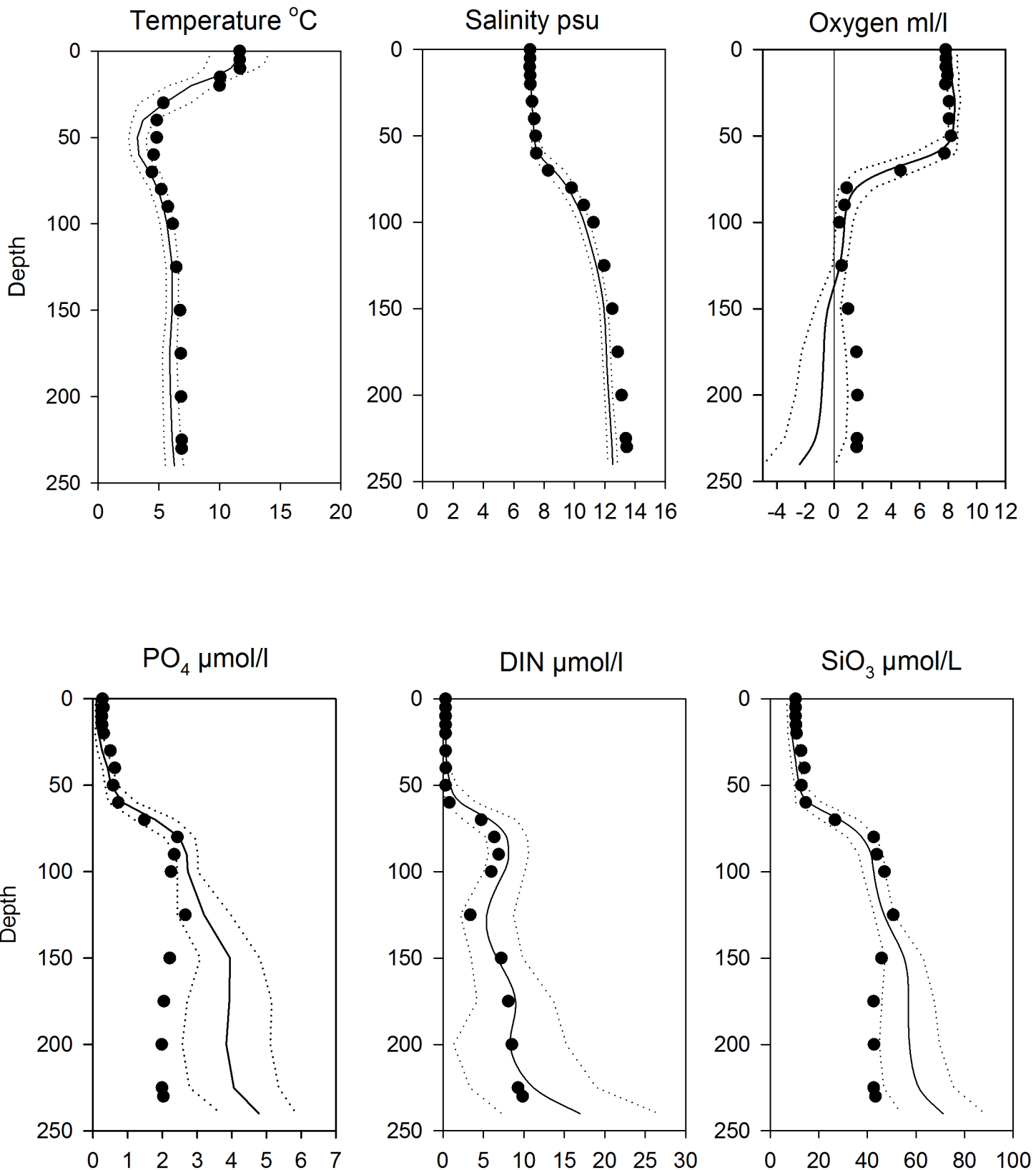
## OXYGEN IN BOTTOM WATER (depth >225m)





# Vertical profiles BY15 June

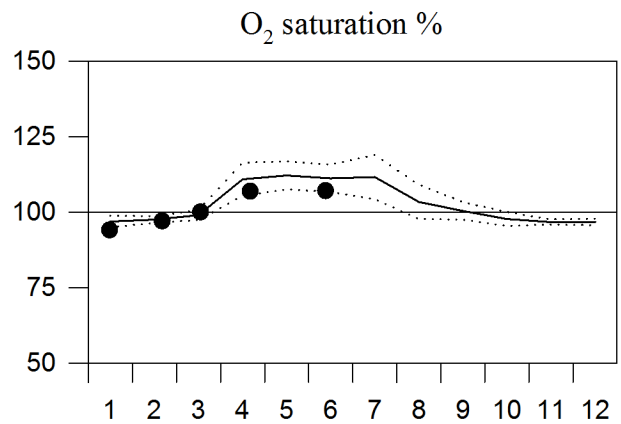
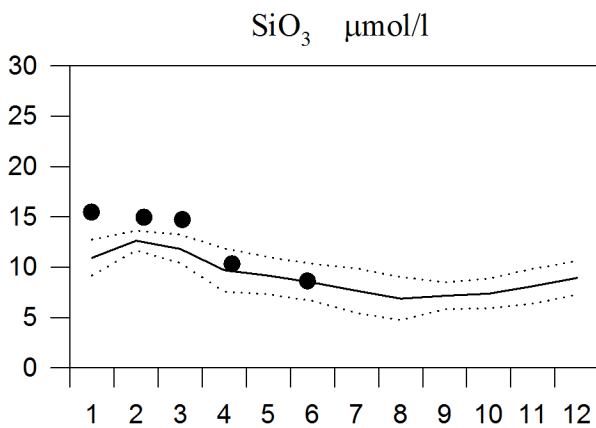
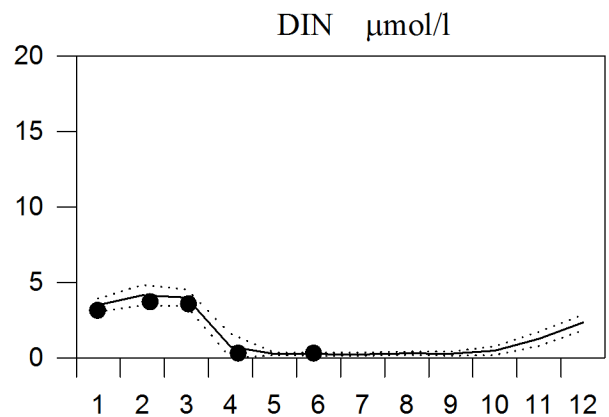
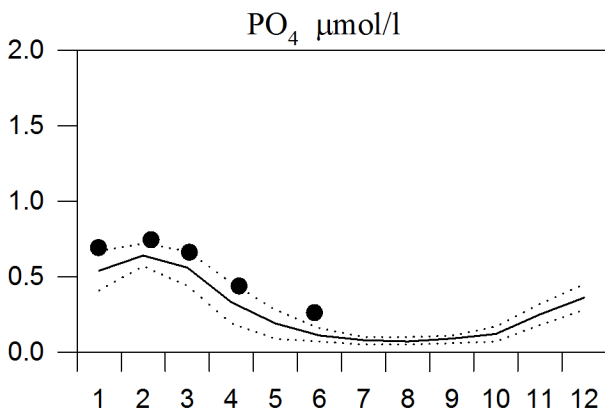
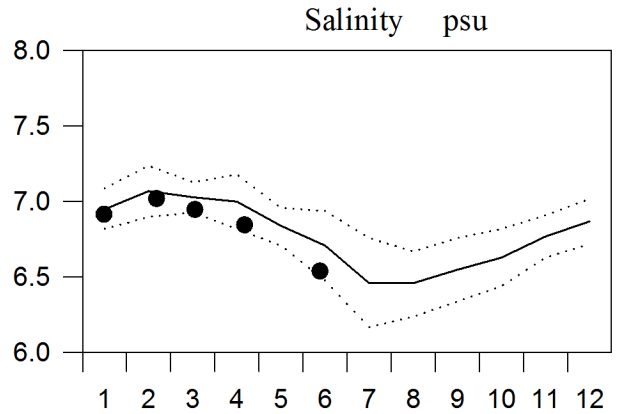
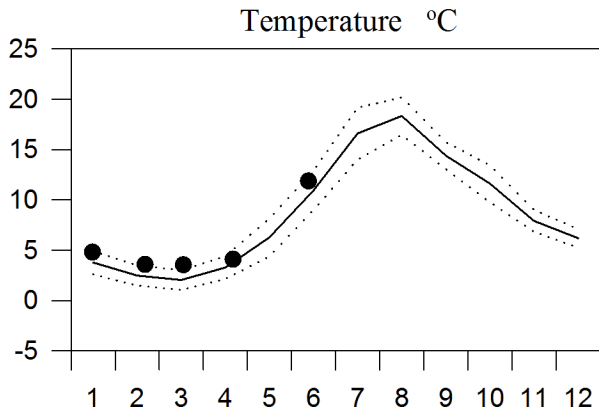
— Mean 1996-2010      ..... St.Dev.      ● 2015



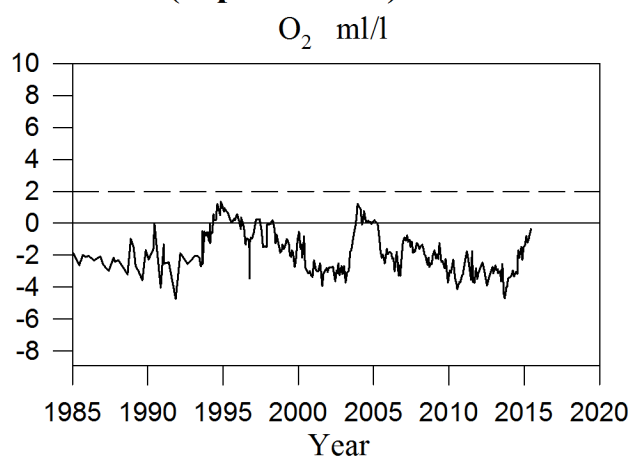
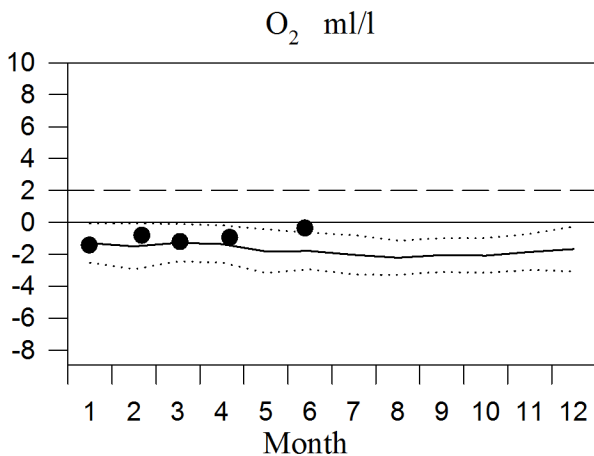
# STATION BY20 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

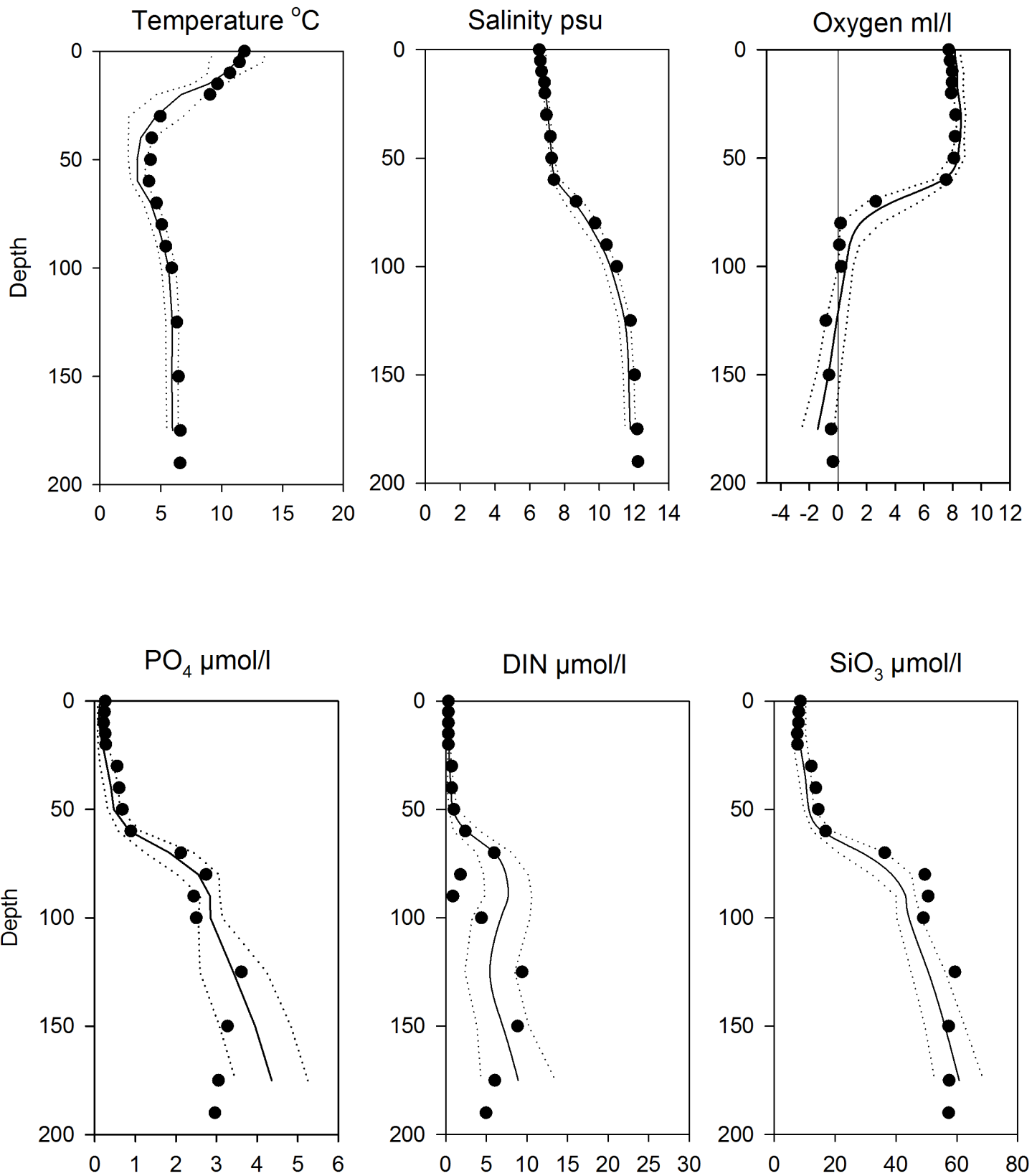


## OXYGEN IN BOTTOM WATER (depth >175m)



# Vertical profiles BY20 June

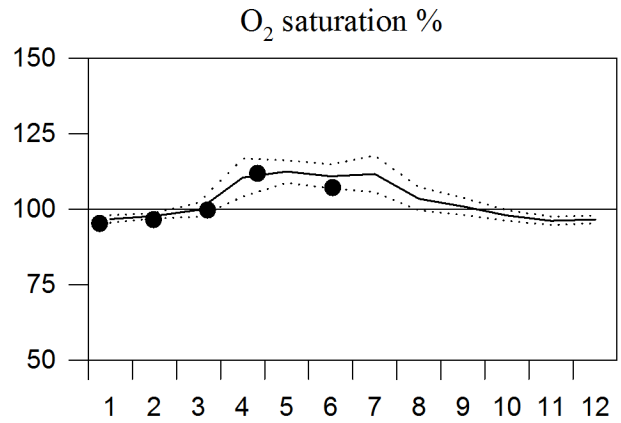
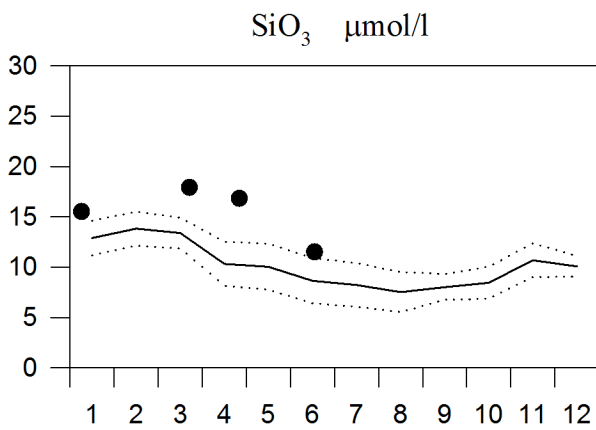
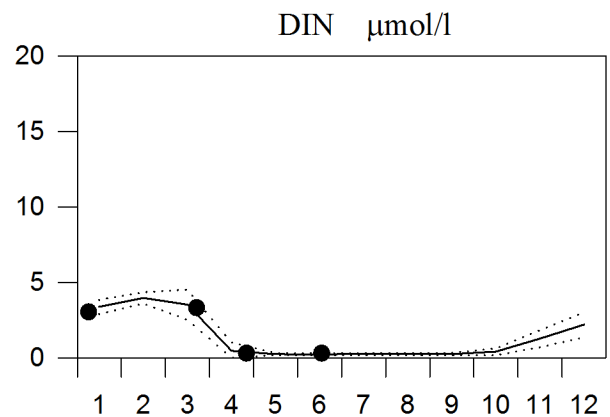
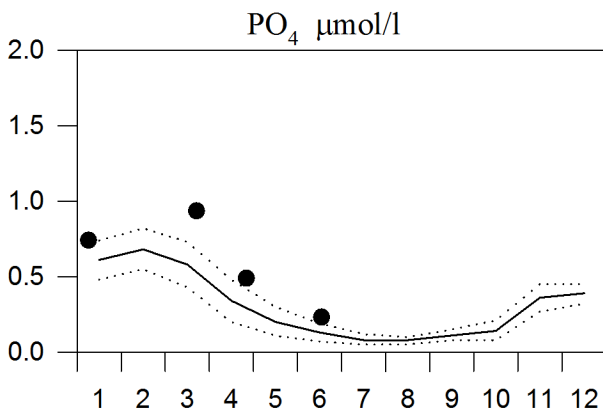
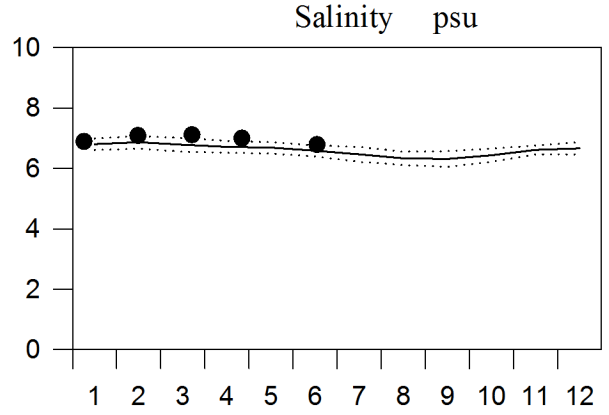
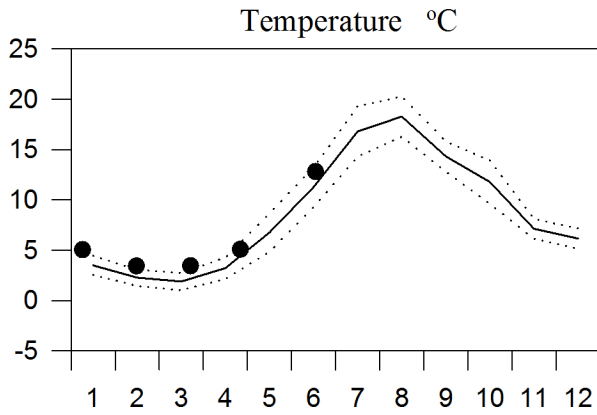
— Mean 1996-2010      ····· St.Dev.      ● 2015



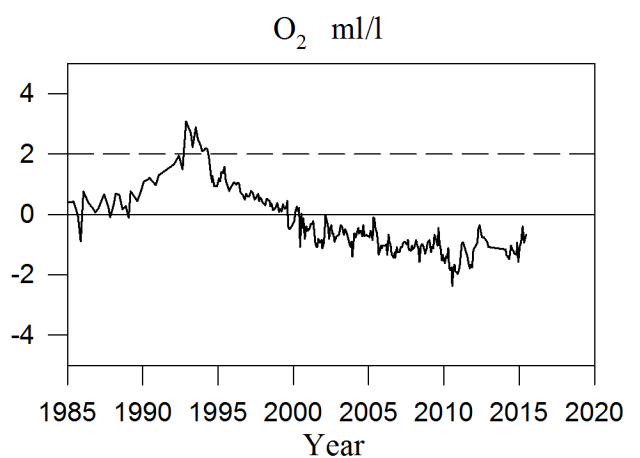
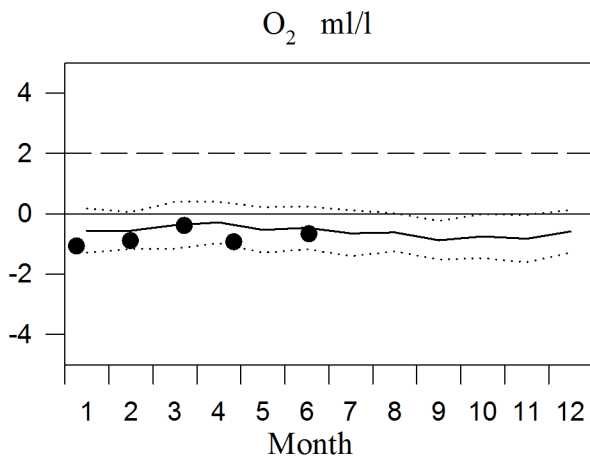
# STATION BY32 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

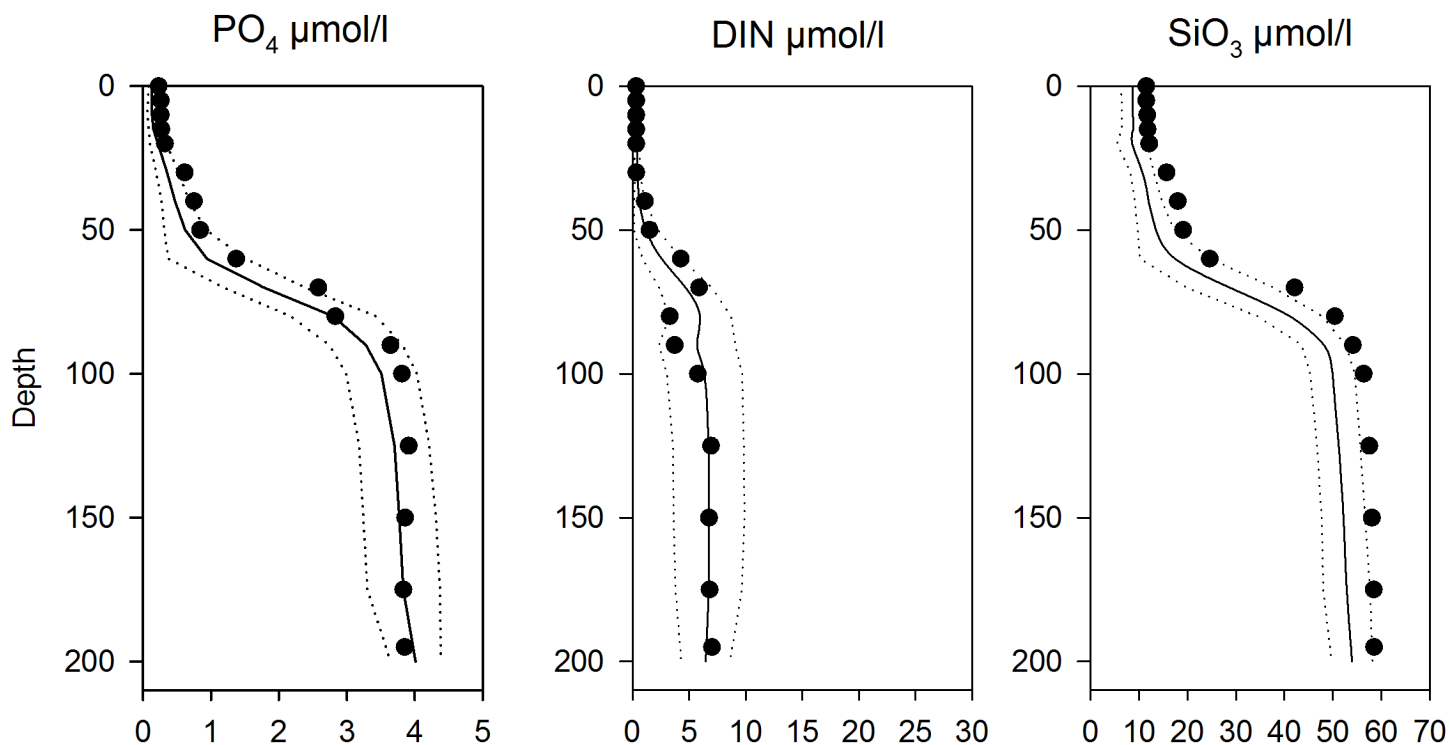
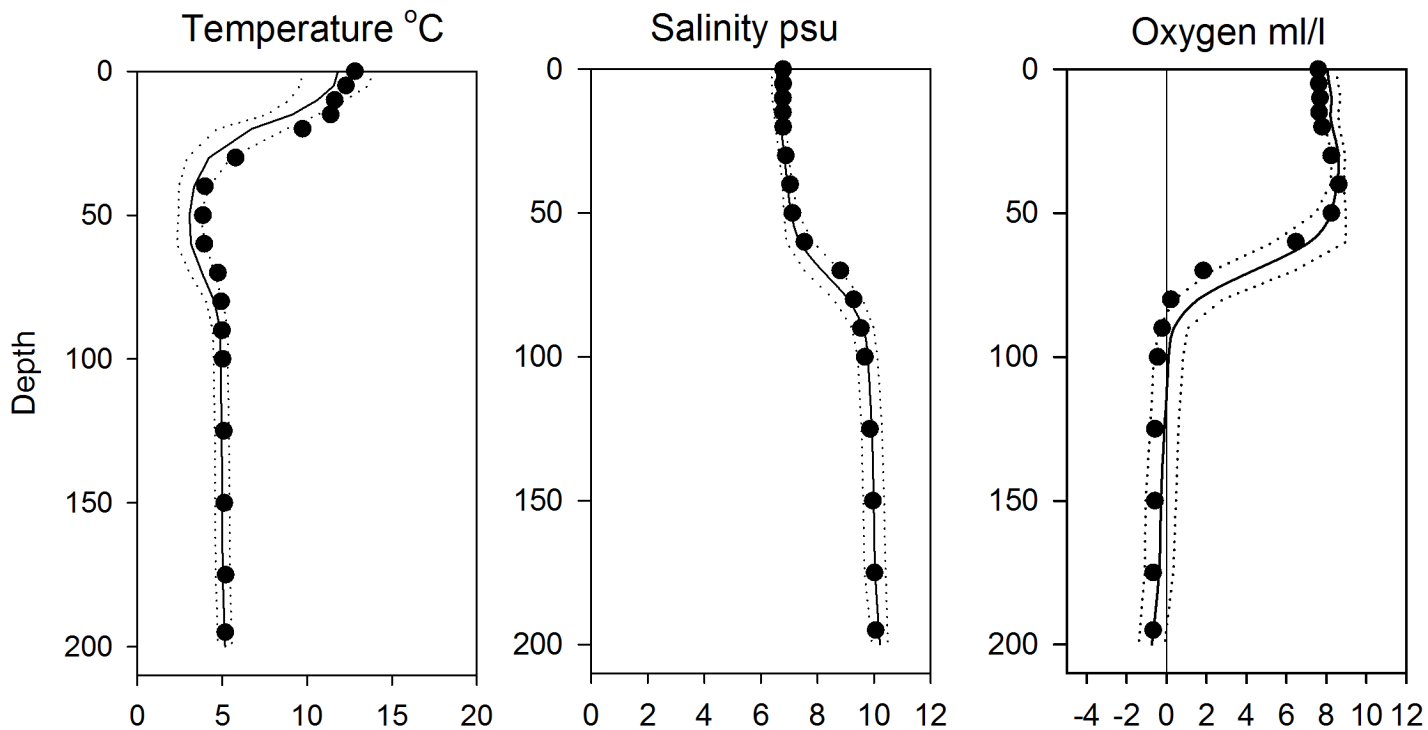


## OXYGEN IN BOTTOM WATER (depth > 175m)



# Vertical profiles BY32 June

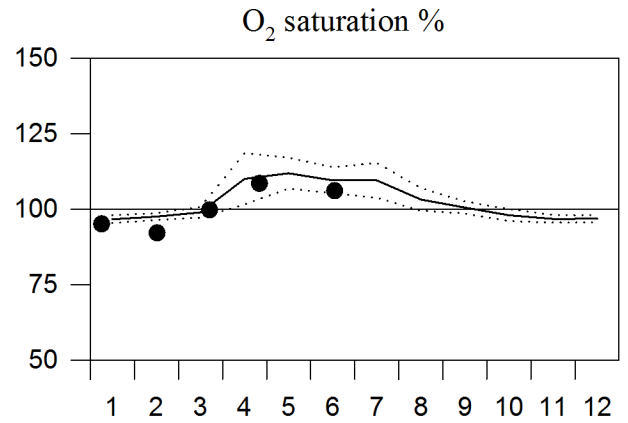
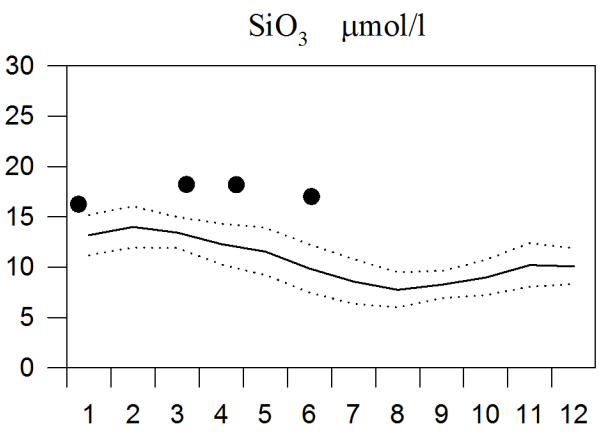
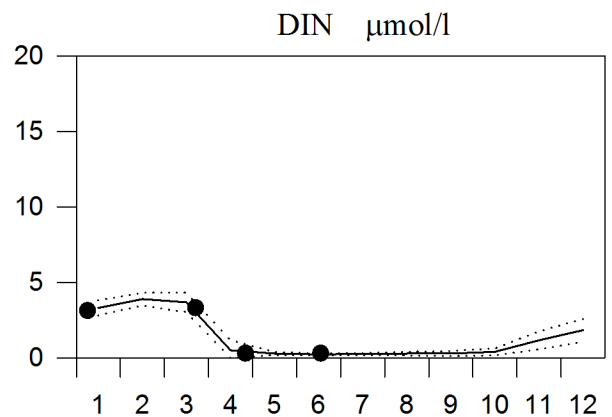
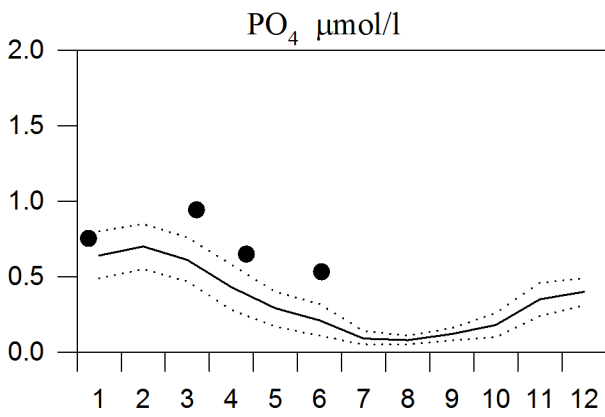
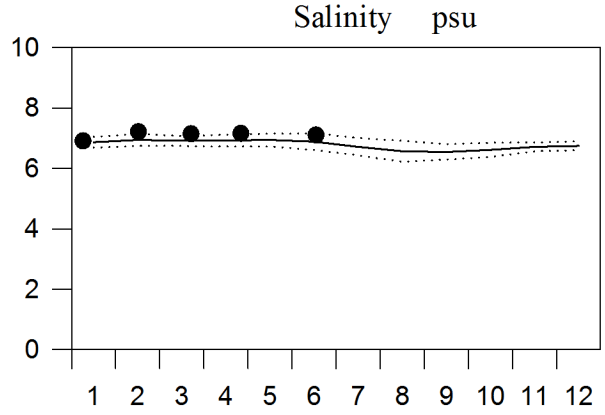
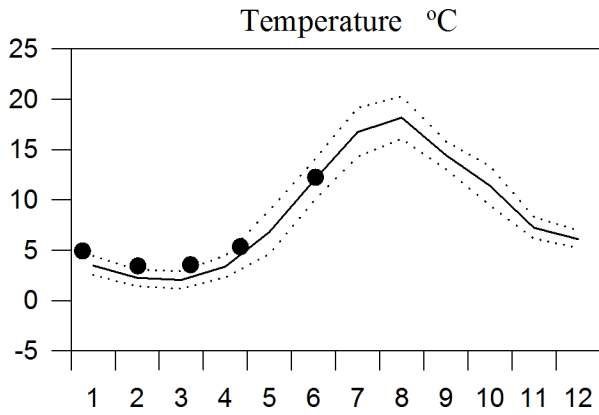
— Mean 1996-2010      ····· St.Dev.      ● 2015



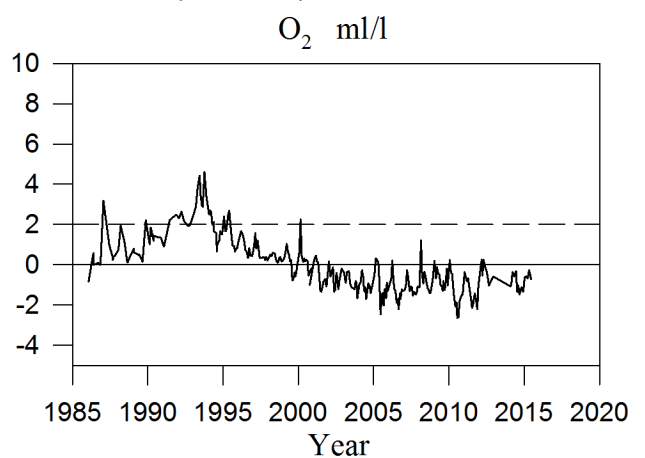
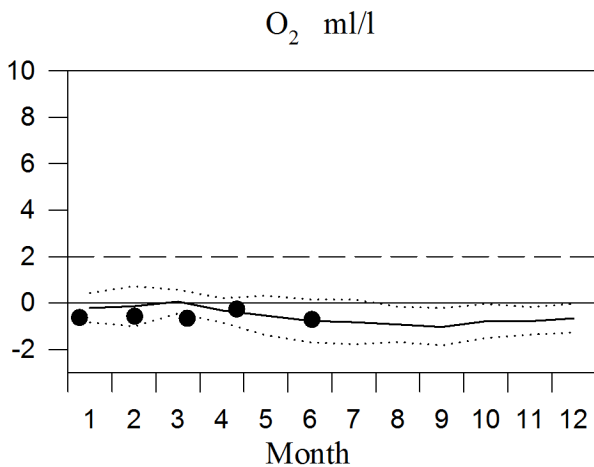
# STATION BY38 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015

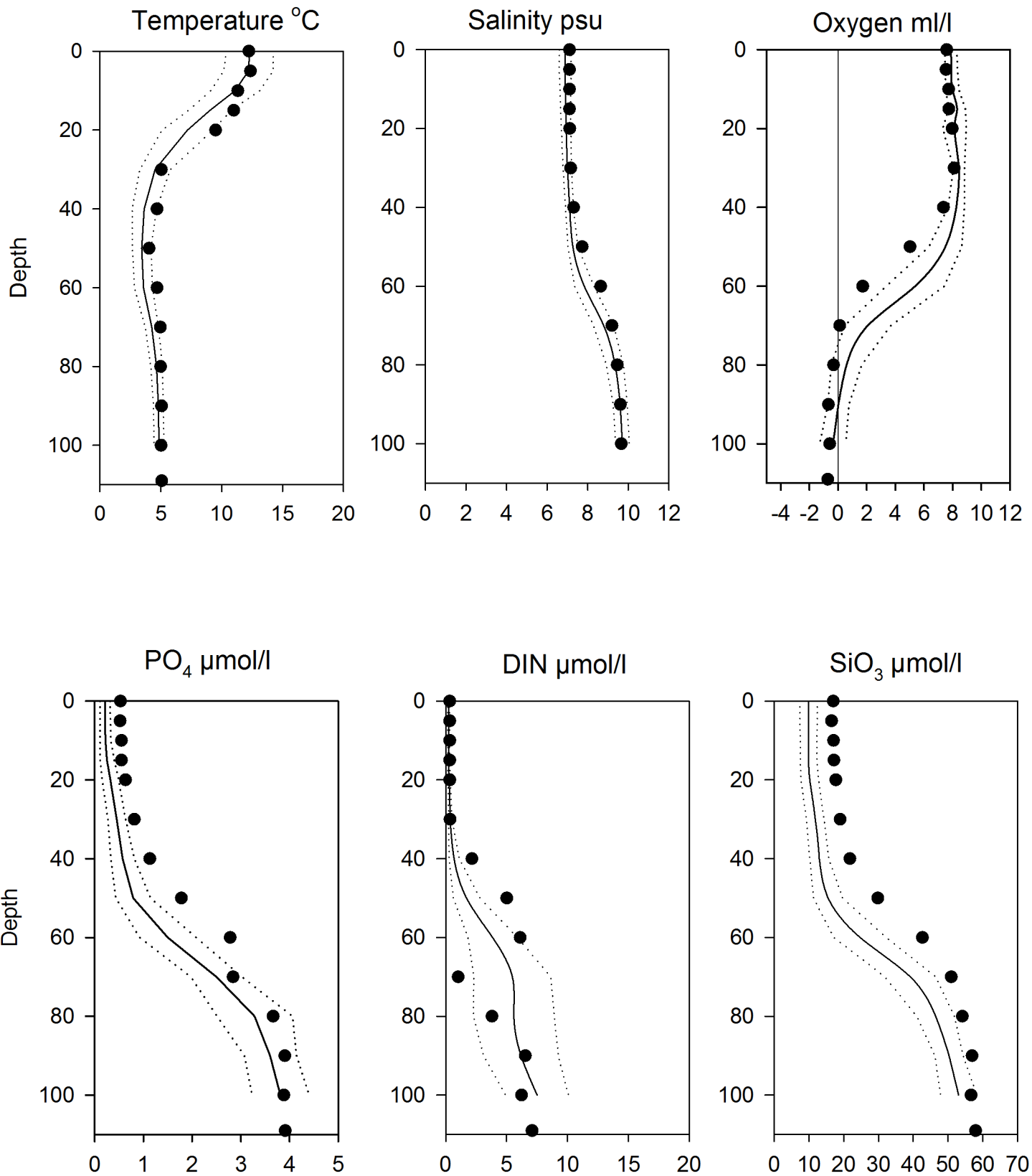


## OXYGEN IN BOTTOM WATER (> 100m)



# Vertical profiles BY38 June

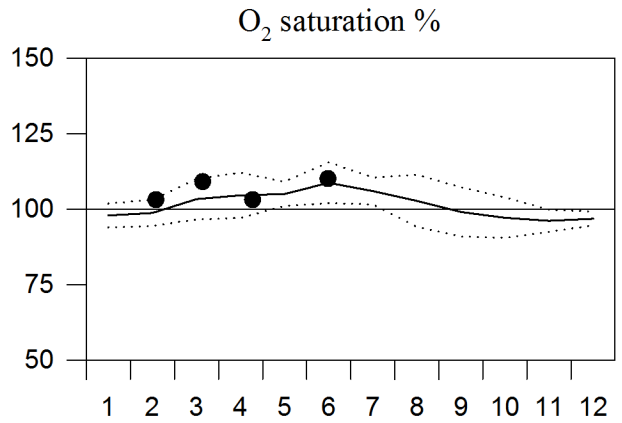
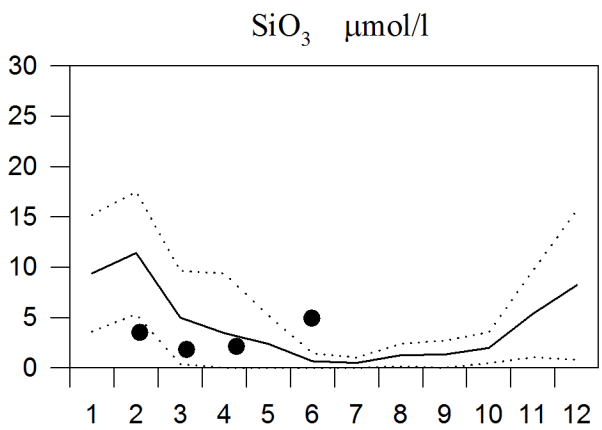
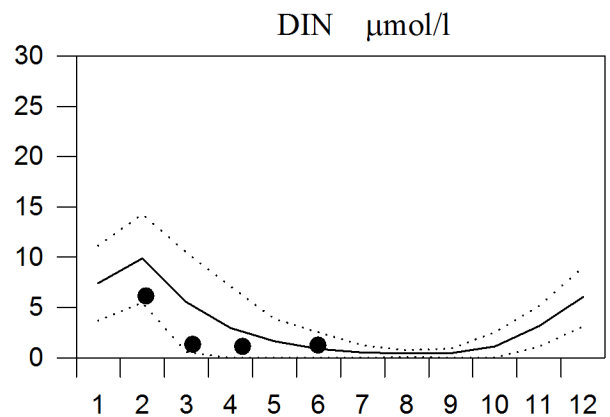
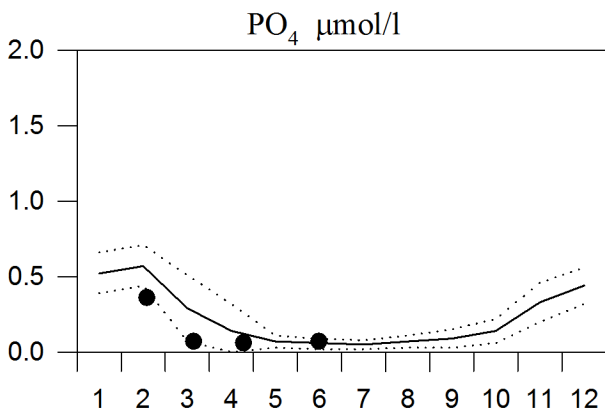
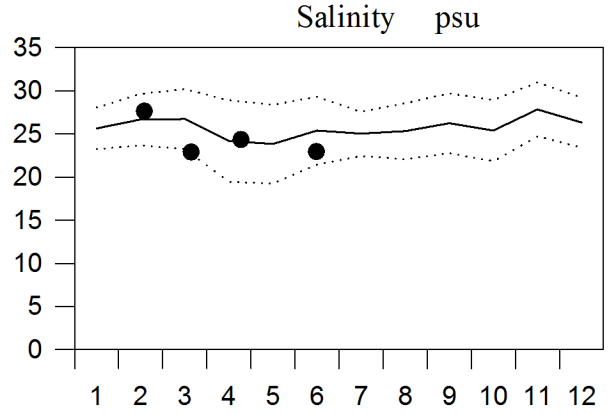
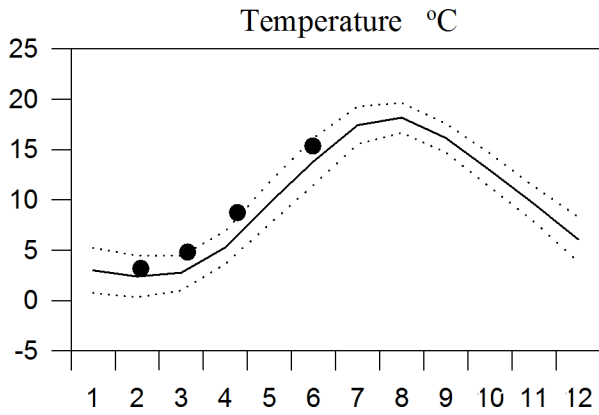
— Mean 1996-2010      ····· St.Dev.      ● 2015



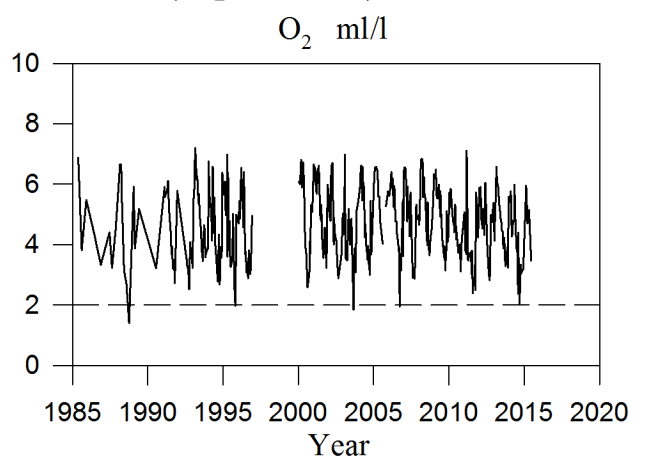
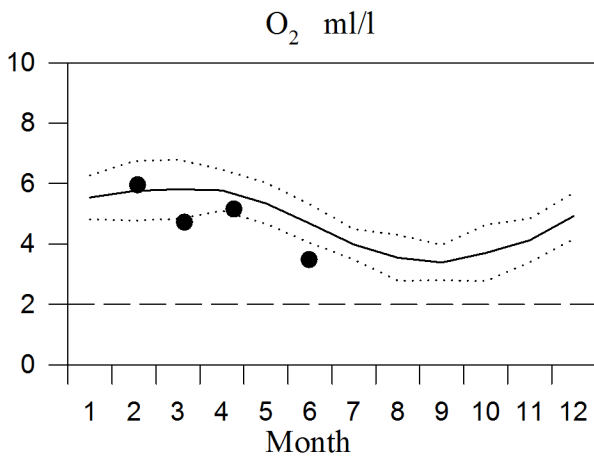
# STATION SLÄGGÖ SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ..... St.Dev.      ● 2015



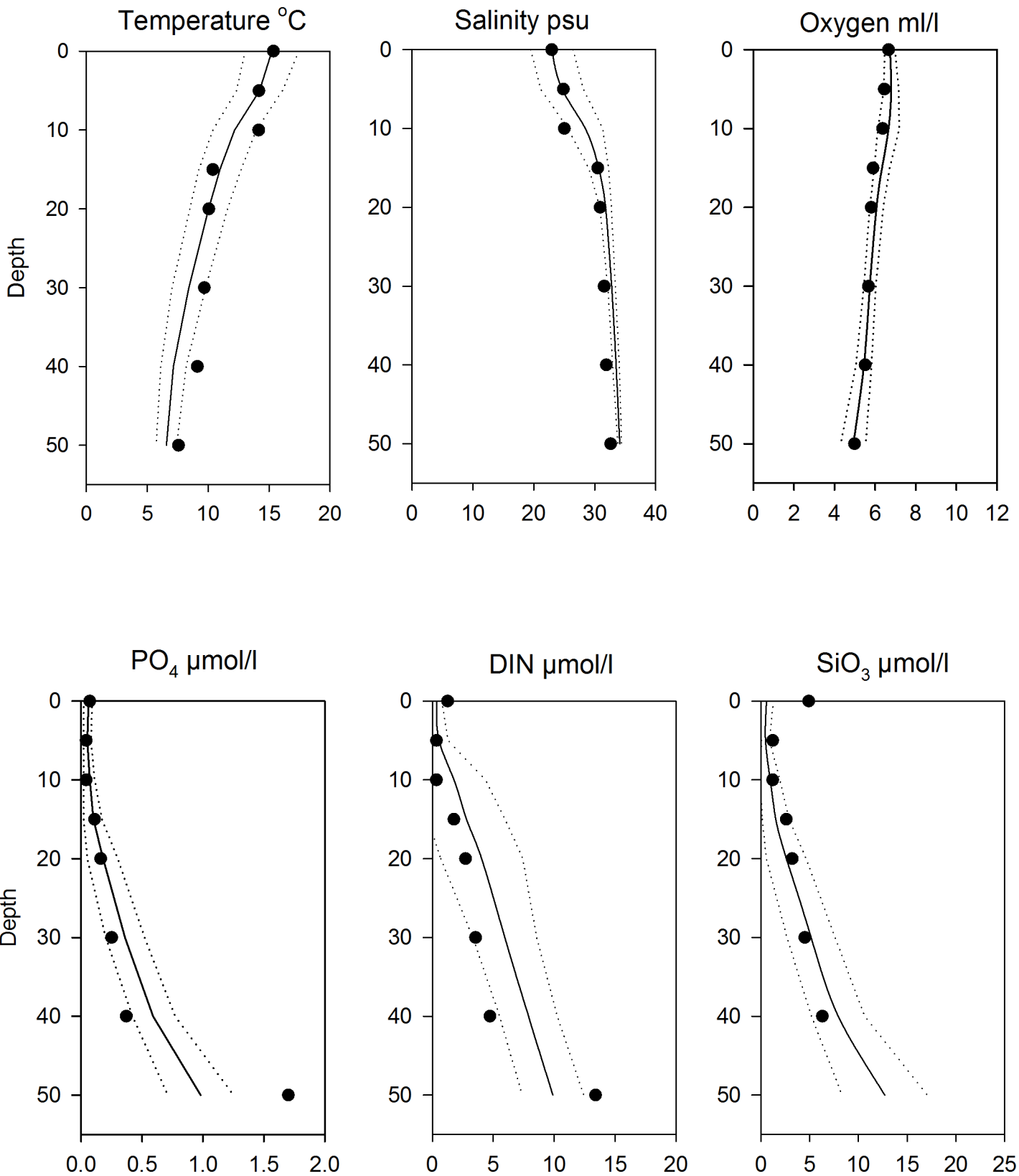
## OXYGEN IN BOTTOM WATER (depth >50m)





# Vertical profiles Släggö June

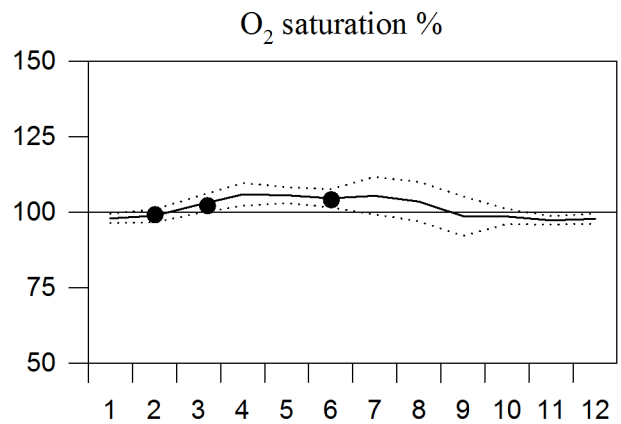
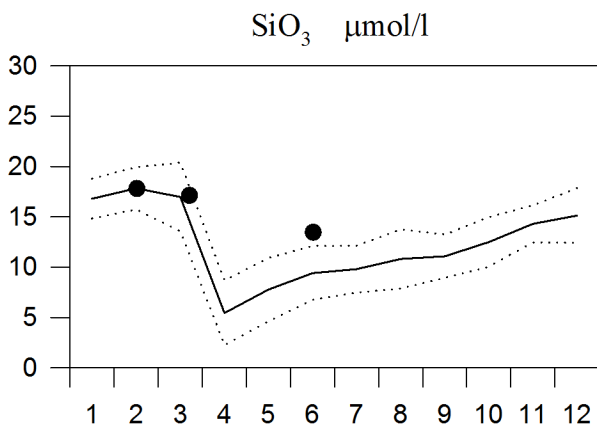
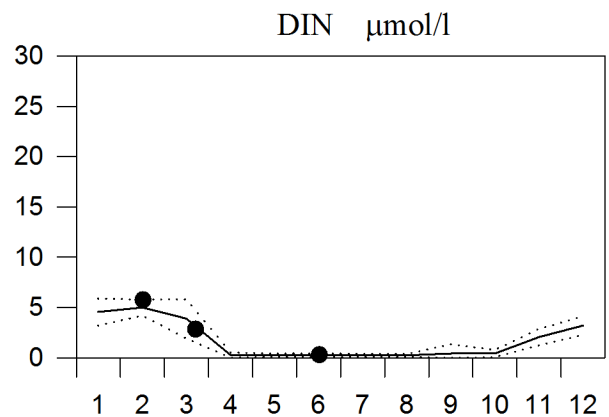
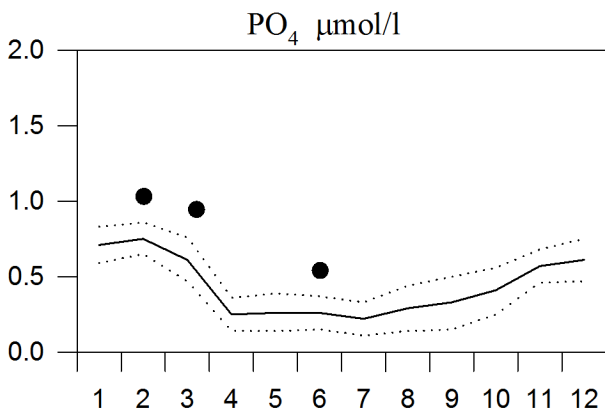
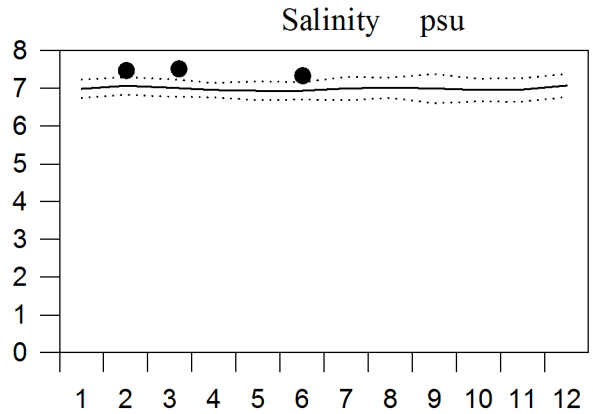
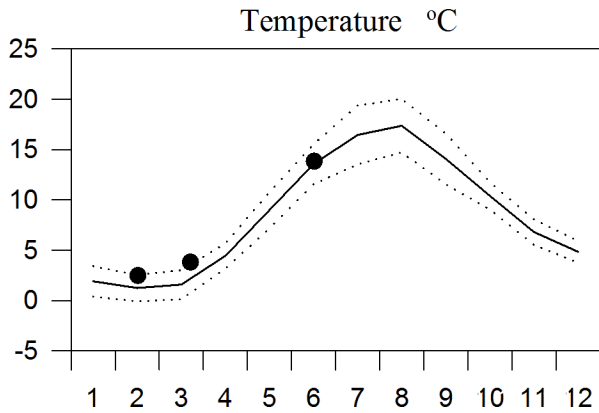
— Mean 1996-2010      ..... St.Dev.      ● 2015



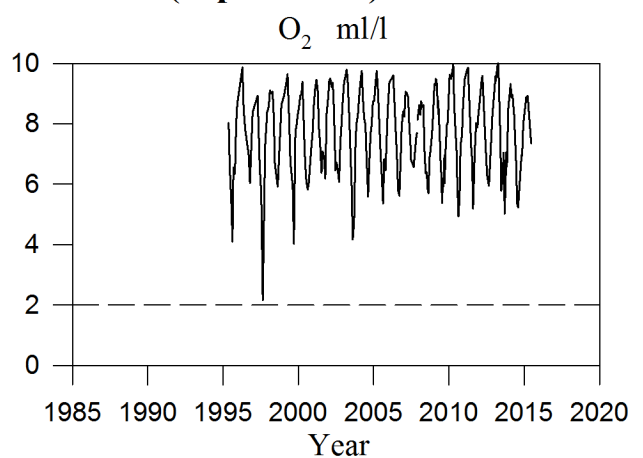
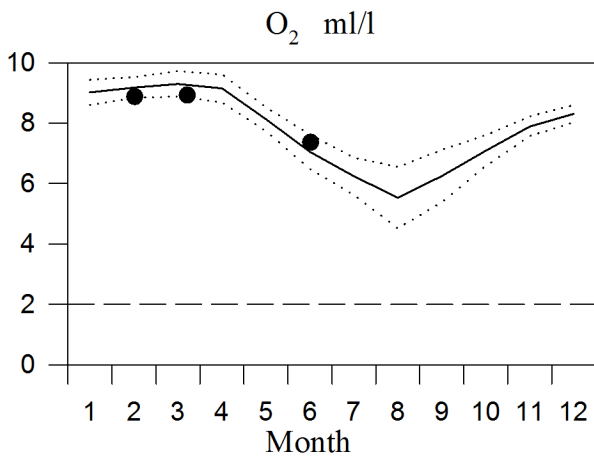
# STATION REF M1V1 SURFACE WATER

## Annual Cycles

— Mean 1996-2010      ····· St.Dev.      ● 2015



## OXYGEN IN BOTTOM WATER (depth >15m)



# Vertical profiles Ref M1V1 June

— Mean 1996-2010      ..... St.Dev.      ● 2015

